International Marine Engineering

Published Monthly by ALDRICH PUBLISHING CO.

17 BATTERY PLACE, NEW YORK — 31 CHRISTOPHER ST., LONDON, E. C.

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Member Soc. N. A. and M. E.

Vol. XIX — JANUARY, 1914 — No. 1

The Latest United States Battleship

Description of the Battleship Texas, Built by the Newport News Shipbuilding and Dry Dock Co.—Machinery Details and Trial Data

With the completion and acceptance of the U. S. S. *Texas* the United States Navy adds to its now strong and formidable list of battleships one of the staunchest and most successful ships among those recently built for the naval establishment.

The *Texas* and *New York* were authorized by act of Congress approved June 24, 1910, an appropriation of $6,000,000 (£1,230,000) for the construction of each of these vessels being provided; the above sum being exclusive of armor and armament, together with various fittings usually supplied by the Government.

The contract for the construction of the *Texas* was awarded the Newport News Shipbuilding and Dry Dock Company, of Newport News, Va., at their bid of $5,830,000 (£1,195,000), the time of completion, according to contract, being 36 months, or December 17, 1913. The keel was laid April 17, 1911, the ship was launched May 18, 1912, and the full power trial consummated October 28, 1913.

The *New York*, now building at the New York Navy Yard, is also rapidly nearing completion. The two ships are, with the exception of minor details, practically the same as regards hull and machinery.

The principal hull dimensions of the *Texas* are:

Length over all	573 feet 0 inches
Beam, on load waterline	95 feet 2½ inches
Mean draft	28 feet 6 inches
Block coefficient	0.61
Full load displacement, tons	28,367
Trial displacement, tons	26,250
Capacity of coal bunkers, tons	2,892

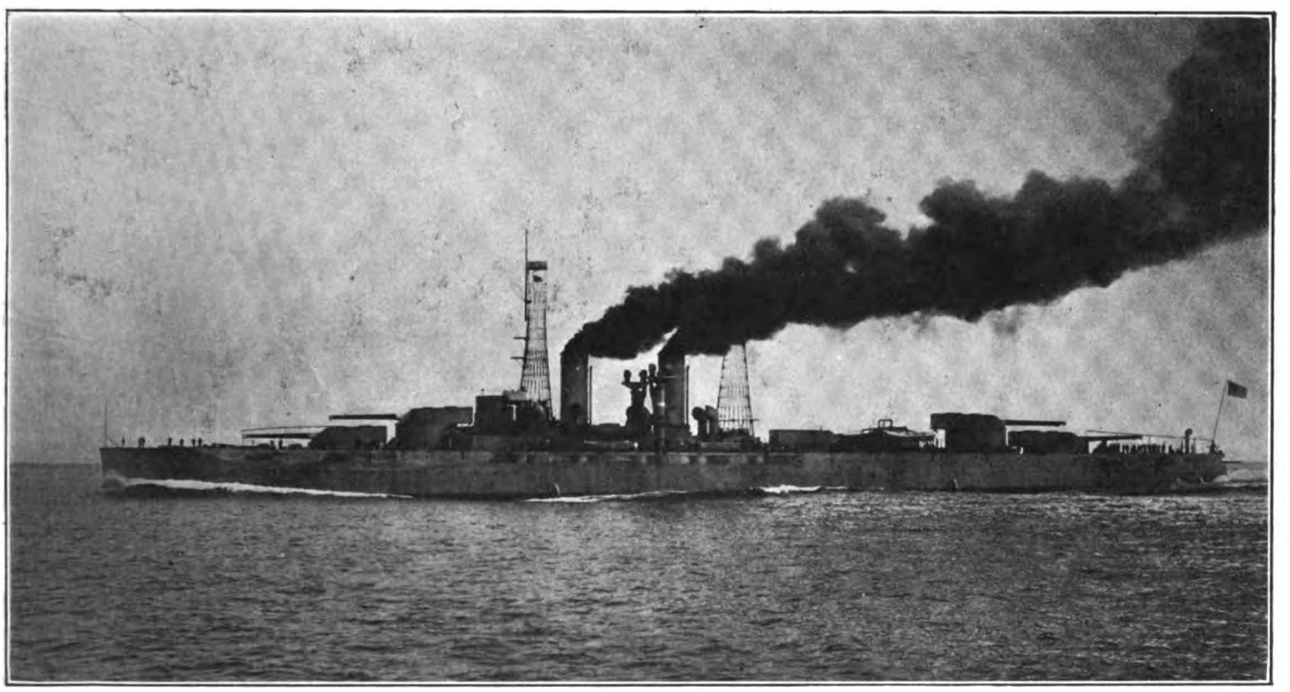

Fig. 1.—Battleship Texas; Average Speed at Full Power 21.05 Knots. (Photograph Copyright by N. L. Stebbins)

The batteries consist of ten 14-inch 45 caliber B. L. R.; twenty-one 5-inch 51 caliber B. L. R. and four 3-pounder saluting guns. There are four 21-inch submerged torpedo tubes.

The general outward appearance of the vessel may be judged from the illustration which is reproduced from a photograph taken on the trial.

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MACHINERY ARRANGEMENT

The general arrangement of the machinery is similar to that of U. S. S. *Delaware*. It consists of the boiler space with three firerooms, having four boilers in each, and one fireroom with two boilers. Two smoke stacks carry off the gases of combustion from the fourteen boilers. There are two engine rooms, divided by a fore and aft bulkhead.

BOILERS

The boilers are all of the Babcock & Wilcox make, eight of them having superheaters, while six are without superheaters. Each boiler is fitted for oil burning as well as for coal, either system being capable of being operated singly or together. The total generating surface, inclusive of superheating surface, is 65,480 square feet and the total grate surface is 1,554 square feet, making a ratio of 1 to 40. Forced draft is on the closed fireroom system.

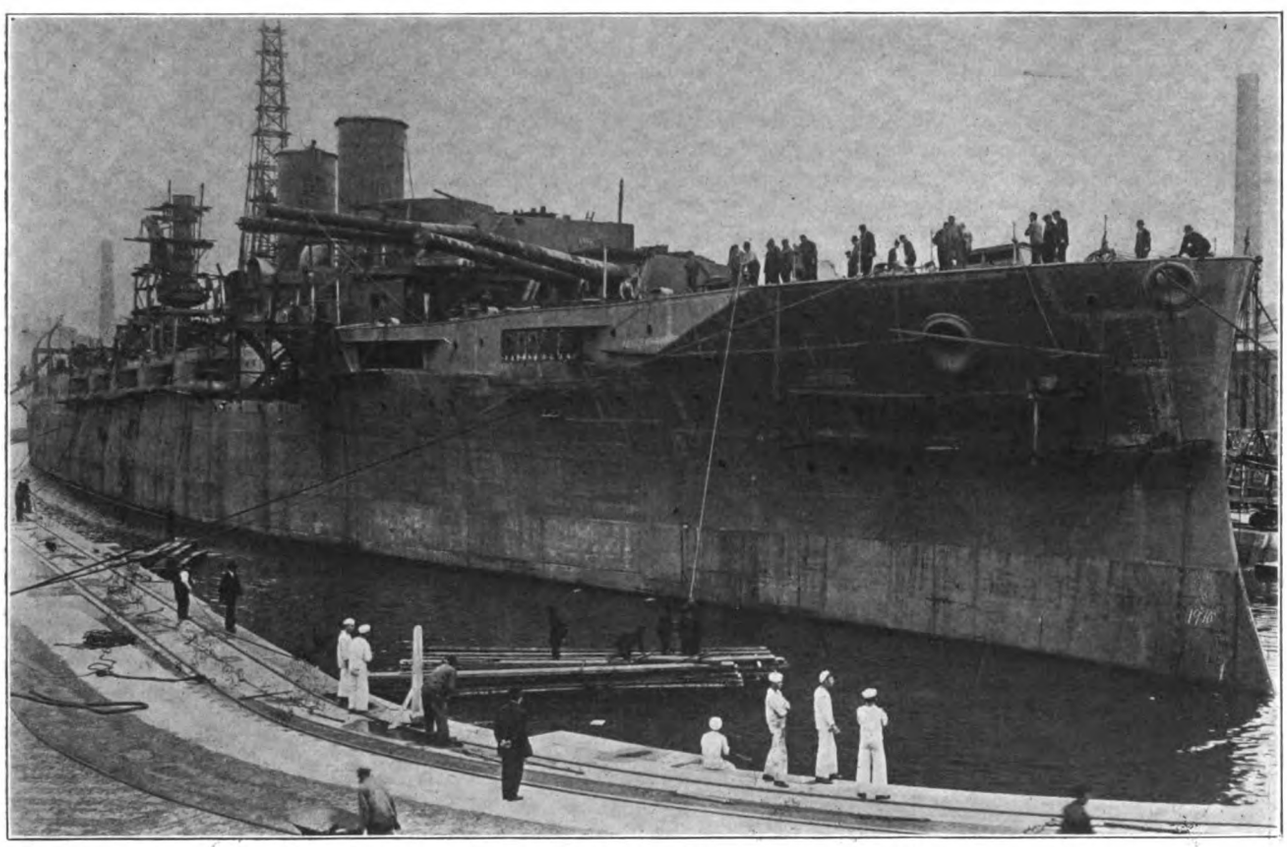

Fig. 2.—Battleship New York in Drydock at Brooklyn Navy Yard

ENGINES

There are installed two vertical inverted direct-acting triple-expansion engines driving twin screws. The specified power of the two main engines combined is 28,100 indicated horsepower when turning over at the rate of 125 revolutions per minute with a steam chest pressure at the high-pressure cylinder of 265 pounds gage without live steam in either receiver and a mean cut-off in the high-pressure cylinder of .82 stroke.

The general arrangement of cylinders is: Forward low-pressure cylinder, high-pressure, intermediate and after low-pressure, with the high-pressure cylinder leading, followed by the intermediate-pressure, forward low-pressure and after low-pressure in the order named. The high-pressure and forward low-pressure cranks are opposite and 180 degrees apart, which is also the case of the intermediate-pressure and after low-pressure cranks, each pair of cranks being 90 degrees apart.

All the cylinders are fitted with piston valves, one for the high-pressure, 22 inches diameter; two for the intermediate-pressure and each low-pressure 24 and 34 inches diameter, respectively; the travel of each valve being 10, 11 and 12 inches, respectively. The framing is built up of turned and finished forged steel columns, cross-braced and longitudinally connected, bolted to the bed plate and cylinder feet by means of heavy flanges. The valve gear is of the Stephenson type, double bar link middle suspended, open eccentric rods. The crank shaft is hollow forged, in two sections, and the bed plate is of cast steel in sections, bolted together.

The reciprocating parts of opposite cylinders are balanced in weight, and the inertia forces and weights of all piston valves are counterbalanced by fitting to each valve a steam-cushioned balance piston of the Lovekin type. Forced lubrication is provided for all main journals and sliding surfaces. The cranks turn outboard for ahead motion.

The length of connecting rods is 96 inches with a crank ratio of 1 to 4. The cylinders are: High-pressure, 39 inches; intermediate-pressure, 63 inches and each low-pressure 83 inches in diameter, with a common stroke of 48 inches. Each intermediate-pressure and low-pressure cylinder barrel is jacketed.

The designed distribution of power among the various cylinders is such as to give about one-third the total to each high-pressure and intermediate-pressure cylinder and about one-sixth to each low-pressure cylinder. Despite the inequality in power between the cylinders the guides, piston rods and connecting rods, crossheads and crank pins are all made of uniform size. This greatly facilitates fitting and carrying of spare parts. The piston rings in high-pressure and intermediate-pressure cylinders are made solid, but the low-pressure cylinder piston rings are split and are provided with

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means for attaining tightness. All valve packing rings are made with a solidly bolted joint, admitting of adjustment for wear.

The cylinder clearances are reduced to a minimum by using practically straight ports. The clearances range from about 12 percent at the top of the high-pressure cylinder to 17 percent at the bottom of the low-pressure cylinder. Piston rods and connecting rods, valve gear and other parts under great stress are made of 95,000 pounds tensile nickel steel; all shafting of 80,000 pounds nickel or carbon steel and propellers of manganese bronze.

The outside diameter of all piston rods is 8¼ inches, that of the thrust shafts 17¾ inches, crank shafts 18½ inches and propeller shafting 18¾ inches diameter.

The thrust bearings are of the horseshoe type, water cooled and fitted with forced lubrication.

CONDENSERS

There is installed one main surface condenser for each main engine with a total cooling surface of 13,104 square feet and two auxiliary condensers of 355 square feet of surface each, placed one in each engine-room. One dynamo condenser of 2,400 square feet of surface is placed in each dynamo room.

FEED HEATERS

Two Reilly multicoil feed heaters each of 295 square feet of coil surface are placed in the engine-rooms, one in each.

PROPELLERS

There is fitted on each shaft a 3-blade manganese bronze propeller, modified Griffith true screw, the diameter being 18 feet 7¾ inches, pitch 20 feet and the projected blade area 87.9 square feet.

AUXILIARIES

In each of the main engine-rooms are installed one circulating pump driven by a compound engine, one Blake vertical twin, single acting air pump, having 35 inches water and air cylinders of 21 inches stroke; two Blake vertical piston double-acting simplex feed pumps, with 9¾ inches water cylinder and 24 inches stroke. In each fireroom there is one auxiliary feed pump of the same type and size as the main feed pump. Besides the foregoing all necessary and usual auxiliaries, such as feed heaters, auxiliary and dynamo condensers, evaporators and distillers, with pumps, fire and bilge pumps, hot well pumps, air compressors, feed tanks, etc., are placed in the ship.

BLOWERS

There is arranged an independent electrically-driven blower set for each boiler, controlled from the boiler room. The motors may be run for a number of different speeds and are, together with the multivane fans, erected in airtight casings placed under the protective deck. These casings communicate with air locks and ventilators.

TRIALS

The standardization trials of the U. S. S. *Texas* were undertaken by the builders on Oct. 23, 27 and 28 on the Government standardization course off Rockland, Me. Of the specified trials the four-hour full-power trial was held Oct. 28, the 19-knot 24-hour trial on Oct. 30-31, the 12-knot 24-hour trial on Oct. 28-29, and the two-hour full-power combination oil and coal trial on Oct. 31.

FOUR-HOUR FULL POWER TRIAL

Steam pressure at boilers, gage	295.6
Steam pressure at engines, gage	271.1
Steam pressure at high-pressure steam chest, gage	246.4
Water used by all machinery per indicated horsepower hour of main engines, pounds	15.06
Coal used per hour per indicated horsepower of main engines	1.73
Average air pressure in firerooms, inches water	1.48
Average vacuum in condenser, inches	26.8
Average vacuum in condenser low-pressure cylinders, inches	24.24
Average revolutions per minute	124.56

	Starboard	*Port*
Indicated horsepower of high-pressure cylinder	4326	4686
Indicated horsepower of intermediate-pressure cylinder	4275	4468
Indicated horsepower of fore low-pressure cylinder	2775	2479
Indicated horsepower of aft low-pressure cylinder	2927	2527
Indicated horsepower total, both engines		28373
Coal used, New River, picked, British thermal units, per pound		14970
Speed in knots		21.05

NINETEEN-KNOT 24-HOUR ENDURANCE TRIAL

Steam pressure at boilers, gage	284.9
Steam pressure at engines, gage	276.5
Steam pressure at high-pressure steam chest, gage	234.3
Water used by all machinery per indicated horsepower hour of main engines, pounds	14.47
Coal used per hour per indicated horsepower of main engines	1.53
Average air pressure in firerooms, inches water	
Average vacuum in condensers, inches	26.82
Average vacuum in low-pressure cylinders, inches	26.53
Average revolutions per minute	110.3

	Starboard	*Port*
Indicated horsepower of high-pressure cylinder	2840	3014
Indicated horsepower of intermediate-pressure cylinder	3150	2971
Indicated horsepower of fore low-pressure cylinder	1764	1649
Indicated horsepower of aft low-pressure cylinder	1735	1656
Indicated horsepower total, both engines		18779
Speed in knots		19.078

TWELVE-KNOT 24-HOUR ENDURANCE TRIAL

Steam pressure at boilers, gage	285.5
Steam pressure at engines, gage	277.7
Steam pressure at high-pressure steam chest, gage	91.94
Water used by all machinery per indicated horsepower hour of main engines, pounds	17.37
Coal used per hour per indicated horsepower of main engines	2.01
Average air pressure in firerooms, inches water	
Average vacuum in condensers, inches	26.71
Average vacuum in low-pressure cylinders, inches	26.2
Average revolutions per minute	69.26

	Starboard	*Port*
Indicated horsepower of high-pressure cylinder	711	815
Indicated horsepower of intermediate-pressure cylinder	788	716
Indicated horsepower of fore low-pressure cylinder	420	394
Indicated horsepower of aft low-pressure cylinder	420	376
Indicated horsepower total, both engines		4640
Speed in knots		12.137

Besides the foregoing trials an additional full power trial

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for combined use of coal and oil was carried out. This trial lasted for two hours.

The steering qualities as well as those pertaining to the seaworthiness of the vessel as developed during the trials were found in every respect satisfactory. The bearing temperatures throughout the trials were steady, no undue heating being prevalent in any of the working parts.

The splendid performance of the vessel from an economic viewpoint, aside from influences of a highly developed design and excellent workmanship, may incidentally be ascribed to steam conditions which show a fair degree of superheat in the high-pressure cylinders and dry saturated steam in the others. The following table gives an idea of what occurred:

TABLE I

Table of Steam Pressures and Temperatures

	H. P. Cylinder. Steam Engine.	Steam Chest.	I. P. Steam Chest.	L. P. Steam Chest.	C'ndit'n of Steam H. P.	I. P.	L. P.
Pressure, gage	274	246					
Pressure, absolute			91.2	26.5			
Temperature, degrees F.	454.5		322	242.5	Sup. 40	Dry	Dry

An interesting comparison of steam consumption of the machinery of the U. S. S. *Delaware* and U. S. S. *Texas* may be partially inferred from the following table. It is, however, not possible to sharply define the relative economic performances of the main engines alone, as the separate data of water consumed by auxiliaries and main engines on the *Texas* were not obtained. But as the main engines of the *Texas* developed practically the same horsepower as did the *Delaware's* main engines, the horsepower of the auxiliaries of the two ships is probably nearly the same. Furthermore, as the type of the auxiliaries conforms very closely in the two ships, the steam used by said auxiliaries should be approximately the same. The steam consumption per indicated horsepower of the main engines on the basis assumed is given in Table II.

TABLE II

Full Power Trial

Comparative Table of Performances of U. S. S. Texas and Delaware

	Texas	*Delaware*
Steam pressure at valve chest, gage	246.4	253.
Vacuum in condenser, inches	26.8	26.3
Vacuum at low-pressure cylinder exhaust, inches	24.24	20.82
Mean referred pressure	44.08	50.9
Piston speed	996	1027
Live steam in receivers	No	No
Steam jackets	*	†
Cylinder ratio	9.00	7.92
Actual ratio of expansion	11.3	8.71
Superheat at high-pressure valve chest	40° F.	61.6° F.
Forced lubrication	Yes	Yes
Steam consumption in pounds per hour per indicated horsepower of main engines, based on total steam used by main engines plus auxiliaries	15.06	14.79
Steam consumption in pounds per hour per indicated horsepower of main engines, based on total steam used by main engines only (estimated)	13.64	13.32

*I. P. and L. P. cylinder barrels.

†All cylinder and top and bottom I. P. and L. P. barrels.

SHIPBUILDING RETURNS.—According to the monthly reports of the Bureau of Navigation, 83 sailing, steam and unrigged vessels of 12,687 gross tons were built and officially numbered in the United States during the month of November, 1913. Six of these, aggregating 2,441 gross tons, were steel steamships, all of which were built on the Atlantic Coast.

Unusual Shipbuilding Record in Russia

What is said to be a world's record in the annals of shipbuilding, both for the number of important ships launched and keel plates laid in a single town during two consecutive days, was made in the town of Nickolaev, Russia, on Oct. 31 and Nov. 1, 1913.

In Russia the expression "laying the keel plate" does not necessarily mean the actual operation of laying the keel from the builders' point of view, for it is applied to the official naval ceremony of placing a small silver tablet inscribed with the name of the vessel at some convenient place along the center vertical keel. This ceremony may be performed some time after the actual construction of the vessel has been commenced, although it is officially known as "laying the keel plate."

PROGRAMME FOR TWO DAYS MENTIONED

Keel Plates Laid

Oct. 31, two 1,000-ton destroyers; Nevsky Works.
Oct. 31, four 1,000-ton destroyers; French Works.
Oct. 31, three 700-ton submarines; Nevsky Works.
Nov. 1, two large cruisers; Russian S. B. Works.

Vessels Launched

Nov. 1, one 24,000-ton battleship; Russian S. B. Works.
Nov. 1, one 600-ton submarine; Baltic Works.
Oct. 31, two 1,000-ton destroyers; French Works.

All of the above events were confined within the town limits of Nickolaev, which is located at the junction of the Bug and Ingoul Rivers, about 40 miles up the Bug from the north shore of the Black Sea. Nickolaev has a population of about 150,000, and it is safely estimated that at least 100,000 persons witnessed the launching of the battleship and submarine on Nov. 1.

The yards at which these vessels are being built are located on the Ingoul River, and are directly opposite each other. The lofty south bank of the river curves around these shipyards in such a manner that it forms a colossal amphitheater, and offers an unobstructed view for witnessing the launches for more than a mile on either side of the works.

Besides the opportunity of witnessing two successful launches within thirty minutes of each other, the spectators were treated to a military and naval display of medieval pomp and splendor such as Russia alone can produce without the least affectation.

Hamburg-American Line's Despatch Tender

An interesting despatch tender has recently been added to the fleet of the Hamburg-American Line. This is a 60-foot steel steam launch, delivered this fall, having the distinction of bearing the name *Hamburg-American Line No. 4.* She was designed and built by the Gas Engine & Power Company and Charles L. Seabury Company, Con., Morris Heights, New York City, who developed a type of boat to be used the year round, to stand constant service in New York harbor, in all conditions of weather and harbor traffic, and to be capable of landing at all docks and piers.

The principal service of this boat is carrying company officials and despatches between the Hamburg-American Line piers at Hoboken and South Brooklyn, and at West Twenty-third street, New York City. It is necessary for this company to have the same party visit these same points practically every day. The tunnels, subways, ferries and surface cars combined proved to be a waste of much valuable time, and the inconvenience and delay were such that in some instances it was impossible to complete the trip, so this launch was called upon to remedy this trouble, and has proved herself to

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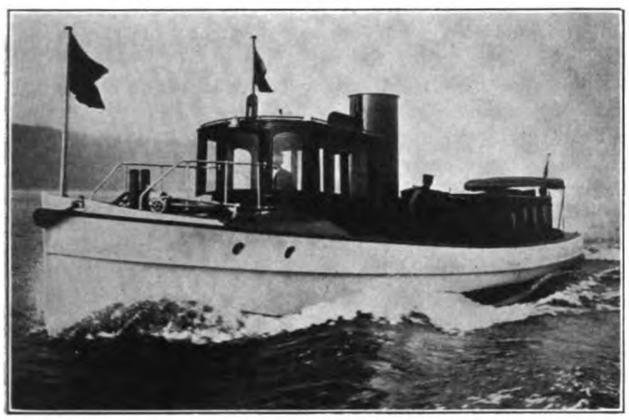
be a success as a time-saver, a convenience and a comfort to the company.

The dimensions of the boat are: Length, 60 feet; beam, 10 feet; draft, 5 feet. The hull is built of steel, with steel watertight bulkheads. She is propelled by a Seabury marine steam fore-and-aft compound vertical engine, with cylinders 6 inches and 12 inches diameter by 9-inch stroke, steam for which is supplied by a Seabury patent safety watertube boiler. The launch has a speed of 12 knots.

The lines of the boat are those of a trim, seaworthy, staunch



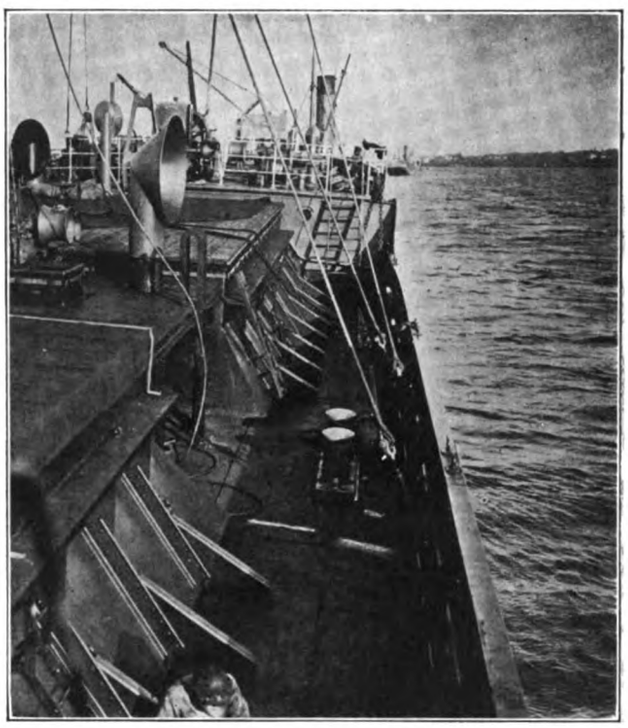
Hamburg-American Line No. 4

vessel. There is a turtle deck forward, with hand rail. Next aft is a roomy pilot house built of selected mahogany, with plate-glass windows, giving the steersman excellent facilities for controlling the boat. The machinery compartment is arranged amidships. The after trunk cabin is built of selected mahogany, with side seats fitted with upholstered cushions. There is a toilet compartment in the forward part of the cabin, while next aft is a cockpit covered with a canvas khaki awning.

The *Hamburg-American Line No.* 4 is constantly seen ploughing her way between the liners, tugs and ferryboats under the most severe conditions in New York harbor and Hudson River, and makes a very creditable showing for a boat of her size.

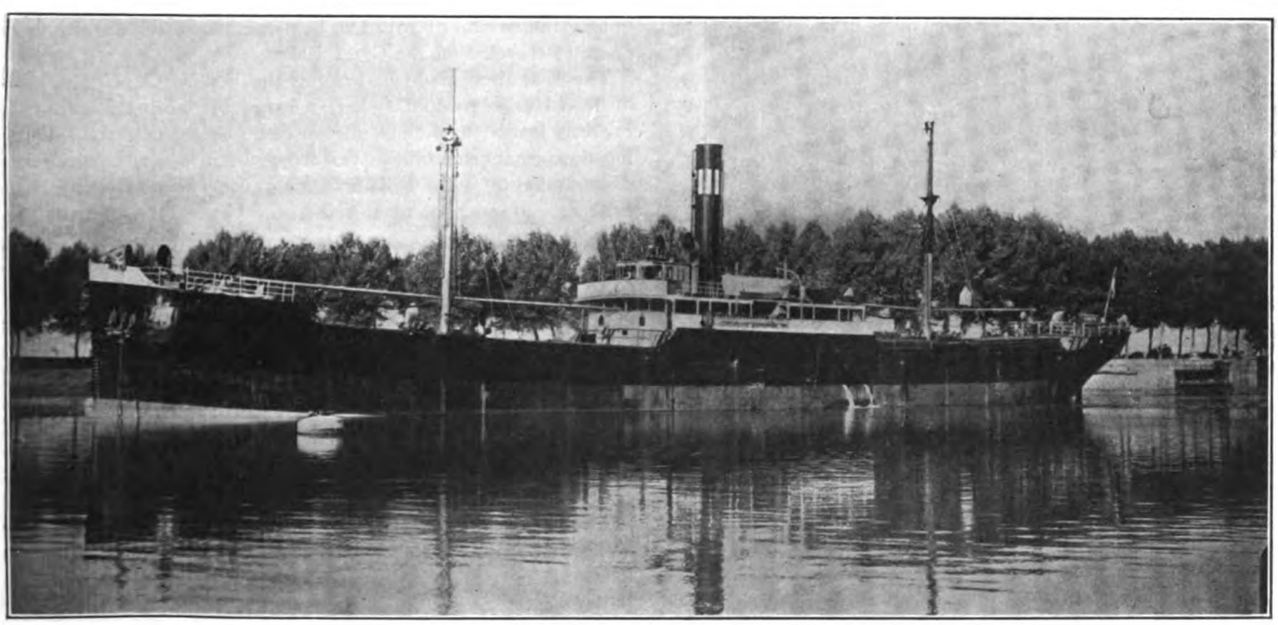
Cargo Steamer Henriette

An interesting cargo vessel belonging to the new firm of Cie. Auxiliare de Navigation of Nantes and Paris, France, was built recently by the Ateliers & Chantiers de la Loire at their Nantes yard. The design of the vessel was worked out by the technical staffs of both the owners and builders. The dimensions are: Length over all, 278 feet 2 inches; beam, 39 feet 6 inches; draft, full load, 19 feet 9 inches; deadweight capacity, 3,105 tons; gross registered tonnage, 1,241; speed, 10 knots.



Deck View of Henriette

The hull is built with a double bottom, divided into five compartments, which have a total capacity of 485 tons of



Cargo Steamer Henriette, Average Speed on Trials 10.70 Knots

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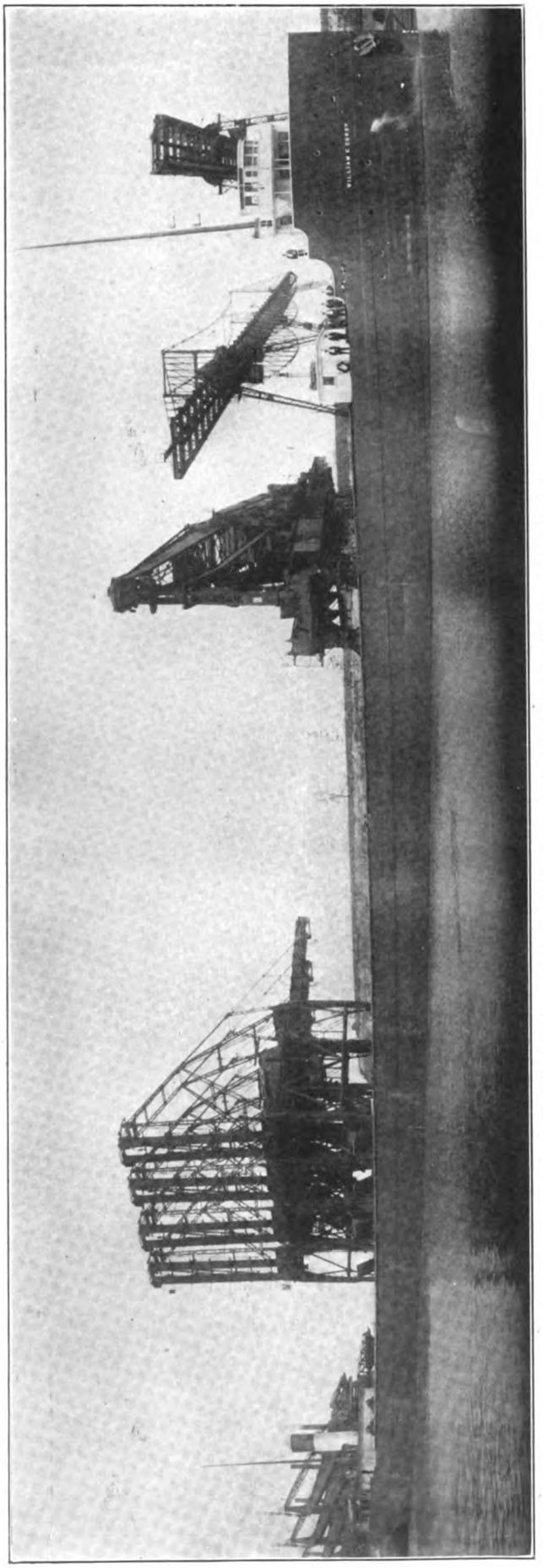

Lake Freighter William E. Corey at the Steel Corporation Docks, Connaut, Ohio

water. In addition, the fore-and-aft peaks have a capacity for 180 tons of water ballast. According to the plans of the owners, special water ballast tanks have been worked under the main deck in the fore-and-aft holds on both sides of the vessel. These tanks have a total capacity of 234 tons of water. Special pumps and piping have been provided, and without interfering with the double bottom tanks they can be filled with water in less than two hours. The object of these special tanks was to avoid heavy strains in both the hull and engines when running in ballast, as frequently happens in a vessel of this type when all of the ballast is carried in the double bottom. This type of construction also increases the strength of the hull and enables the builders to fit hatches of exceptional size, which are needed for the shipment of large pieces of machinery, etc., a class of cargo which commands the highest rates of freight.

There are four watertight bulkheads and each hold is divided by an ordinary steel bulkhead. Propulsion is by a single four-bladed propeller 14 feet in diameter and 11 feet 7 inches pitch, driven by a triple expansion engine with cylinders 18, 30 and 49 inches in diameter and 38 inches stroke. At 95 revolutions per minute the engine develops 1,200 indicated horsepower.

Steam is supplied by two single-ended Scotch boilers, working under a pressure of 185 pounds per square inch. The grate surface is 90 square feet and the heating surface 3,250 square feet. A special type of ash ejector is installed.

Each of the four holds is served by a four-ton steam winch and hollow steel derricks. An extra three-ton winch is fitted aft. The four hatches are of exceptional size and are fitted with coamings of exceptional height, more especially aft, where they extend above the ship's rail.

Record Breaking Freighter on the Great Lakes

BY L. O. WILLIX

Two noteworthy records on the Great Lakes are held by the steamship *William E. Corey*, of the Pittsburg Steamship Company. This vessel was built in South Chicago in 1905, and is one of the finest of the modern type of Lake steamships. Her principal dimensions are: Length over all, 569 feet; beam, 56 feet; molded depth, 35 feet. She has a carrying capacity of 10,200 tons on a mean draft of 19 feet 6 inches. This ship holds the world's record for quick loading, and during the season of 1912 she held the record for the number of miles traveled on the Great Lakes.

The best time made in loading the *William E. Corey* was at Two Harbors, Minn., where a cargo of 10,100 tons of iron ore was loaded in the steamer in twenty-eight minutes. During the present season the vessel has been in commission 206 days, traveling a total distance of 53,653 miles. During that time she burned 7,500 tons of fuel, carrying a little over 27,500 tons of iron ore.

The *Corey* is of the hopper-bottom type of construction, fitted with thirty-three hatches, spaced 12 feet between centers. She is equipped with two Scotch boilers and triple-expansion engines, with cylinders 24, 39 and 65 inches diameter with a common stroke of 42 inches. In light condition she is capable of attaining a maximum speed of 15 miles per hour, and when loaded a speed of 11.6 miles per hour. The best average run made during the past season was from South Chicago to Mackinaw, when she averaged 14.6 miles per hour for a period of 23 hours and 10 minutes.

In addition to her freight-carrying capacity, accommodations are provided in the deck house forward for eight passengers. The passenger accommodations include a galley, dining room, butler's pantry, sleeping rooms with bath rooms attached, a parlor, observation room and library.

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All of these rooms are handsomely finished in quarter-sawed oak, excepting the dining room, which is finished in quarter-sawed birch. A duplicate installation of General Electric dynamos is provided for lighting the ship and heating the passenger quarters.

In the background of the picture of the *William E. Corey,* shown herewith, can be seen the "Hulette" ore unloading rigs at the Steel Corporation Docks at Conneaut, Ohio. While these machines are not the fastest machines on the Great Lakes, they are nevertheless capable of unloading one of the largest freighters in about four hours.

Relative Resistances of Some Models with Block Coefficient Constant and Other Coefficients Varied*

BY NAVAL CONSTRUCTOR D. W. TAYLOR, U. S. N.

Five years ago I had the honor to read before the society a paper dealing with an experimental investigation into the influence of midship section shape upon the resistance of vessels. That paper, as was carefully pointed out in it, dealt with shape and not with area, the sectional area curves for the various shapes being identical. Moreover, it dealt with deep water conditions only.

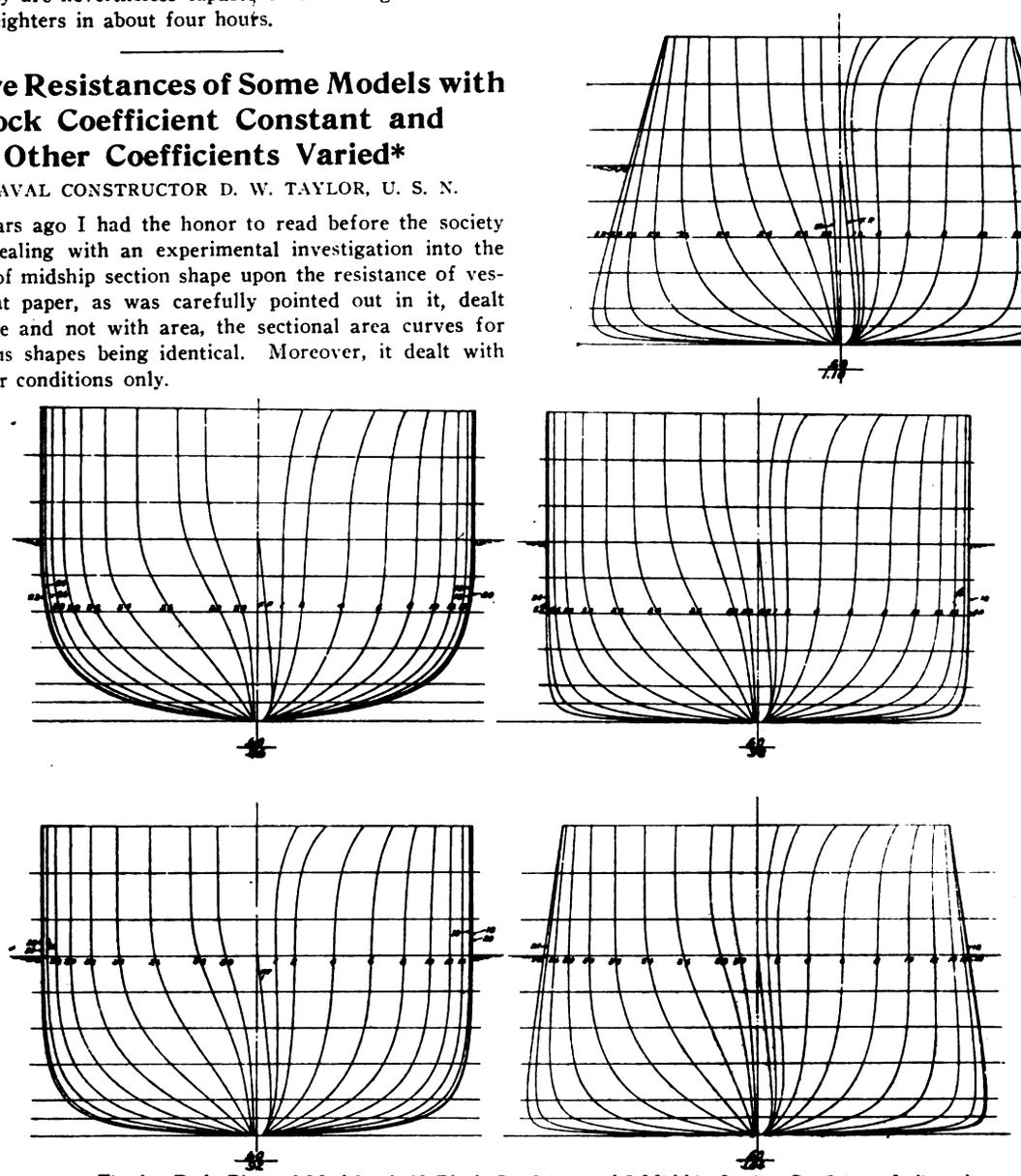

Fig. 1.—Body Plans of Models of .60 Block Coefficient and 5 Midship Section Coefficients Indicated

In this paper I propose to give the results of some investigations where both shape and area vary, and where experiments were made in very shallow as well as deep water.

When in designing a new vessel we have fixed on dimensions and displacement, the block coefficient is fixed. But with a given block coefficient we may adopt a fine midship section coefficient with resulting full ends, or a full midship section coefficient with resulting fine ends.

In the experiments I am dealing with there were 20 models tested. There were four groups of five each, the block coefficients of the group being .56, .60, .64 and .68. The midship section coefficients used with each block coefficient were .86, .92, .98, 1.04 and 1.08. All models were 20 feet long, of 2,500 pounds displacement in fresh water, and 40 cubic feet immersed volume.

Table I gives the dimensions and coefficients for the 20 models. The ratio of breadth to draft was 2.4 in every case, and, of course, with variations of block coefficient there were corresponding slight changes in actual breadth and draft as indicated in Table I.

TABLE I.
DIMENSIONS AND COEFFICIENTS OF MODEL 20 FEET LONG AND 40 CUBIC FEET SUBMERGED VOLUME, OR 2,500 POUNDS DISPLACEMENT IN FRESH WATER.

Block Coefficient	Breadth	Draft	Midship Section Coefficient "m"				
			.86	.92	.98	1.04	1.08
b	B	H	Longitudinal Coefficients				
.56	2.928	1.220	.6511	.6088	.5714	.5384	.5091
.60	2.828	1.179	.6977	.6522	.6123	.5769	.5455
.64	2.739	1.141	.7441	.6956	.6530	.6153	.5818
.68	2.657	1.107	.7907	.7392	.6939	.6538	.6182

*A paper read before the Society of Naval Architects and Marine Engineers, New York, December, 1913.

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Fig. 1 gives the body plans of the five models of .60 block and having midship section coefficients varying from .86 to 1.08, the midship section coefficient being indicated below each body plan. The lines are not perhaps the best to be obtained for speed. Conventional lines we aimed at, although, of course, the higher midship section coefficients are materially greater than used in practice.

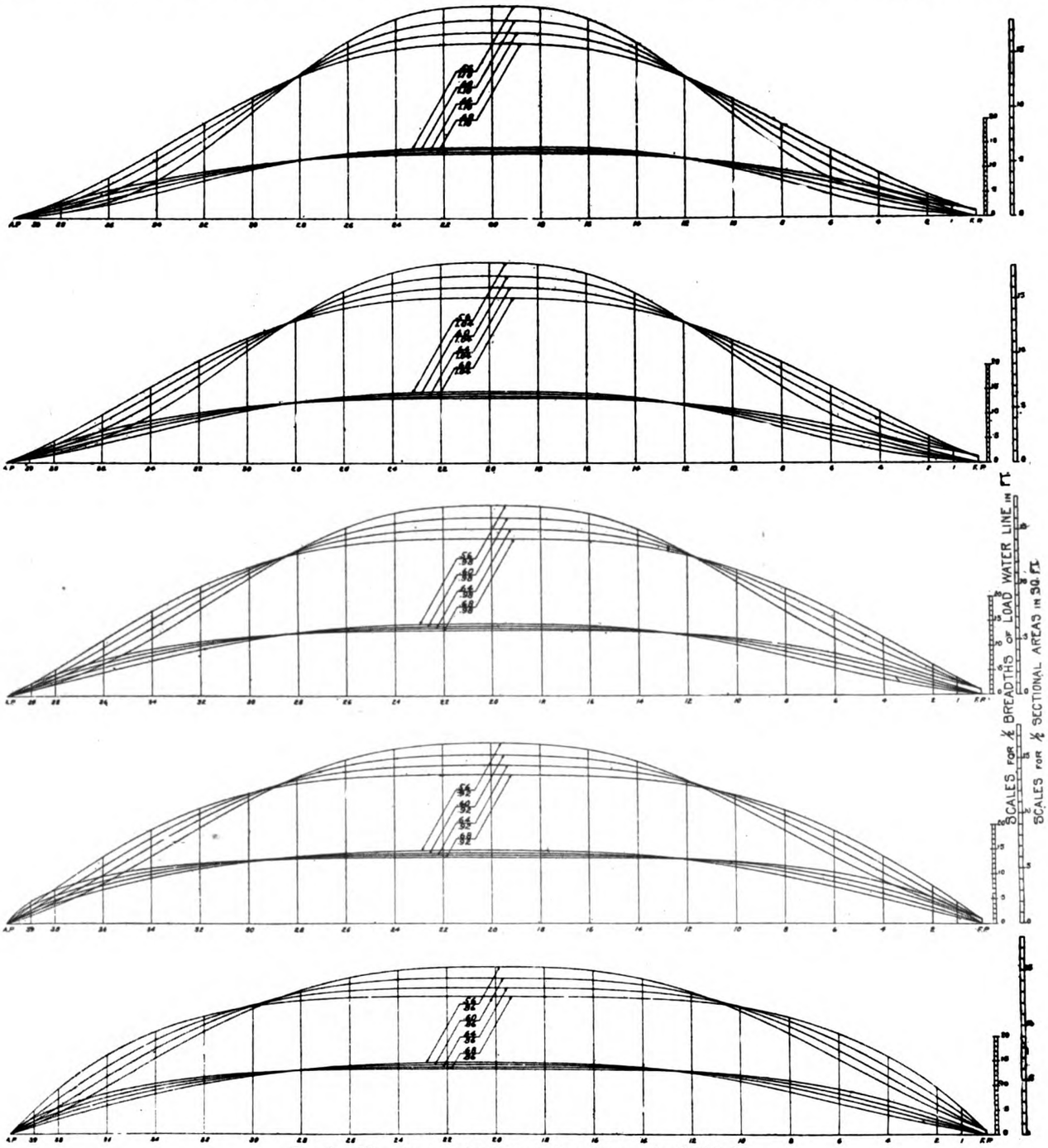

Fig. 2.—Waterlines and Sectional Area Curves for 20 Models

Fig. 2 shows the water lines and sectional area curves for the 20 models. The body plans for the .60 block models shown in Fig. 1 may be regarded as the parent lines for the 15 models of the other block coefficients. The process of transition is simple. Starting with the .60 block model, imagine it expanded or contracted transversely until the midship section area is that for the new block coefficient. This expanded or contracted model will not have the curve of sectional area desired, but by shifting sections forward or aft as required the form with the desired curve of sectional area is readily obtained.

It will be observed in Fig. 2 that the curves of sectional area have a small ordinate at the forward perpendicular. In actually making the models the corners shown are rounded off on the model, the amount removed, however, being infinitesimal.

Fig. 3 shows contours of wetter surface coefficient plotted over the range of midship section coefficient and block coefficient of the 20 models. The wetted surface coefficient is the well-known coefficient C in the formula

$$\text{Wetted Surface} = C \sqrt{DL}$$

where D is displacement in tons in salt water, and L is water line length in feet.

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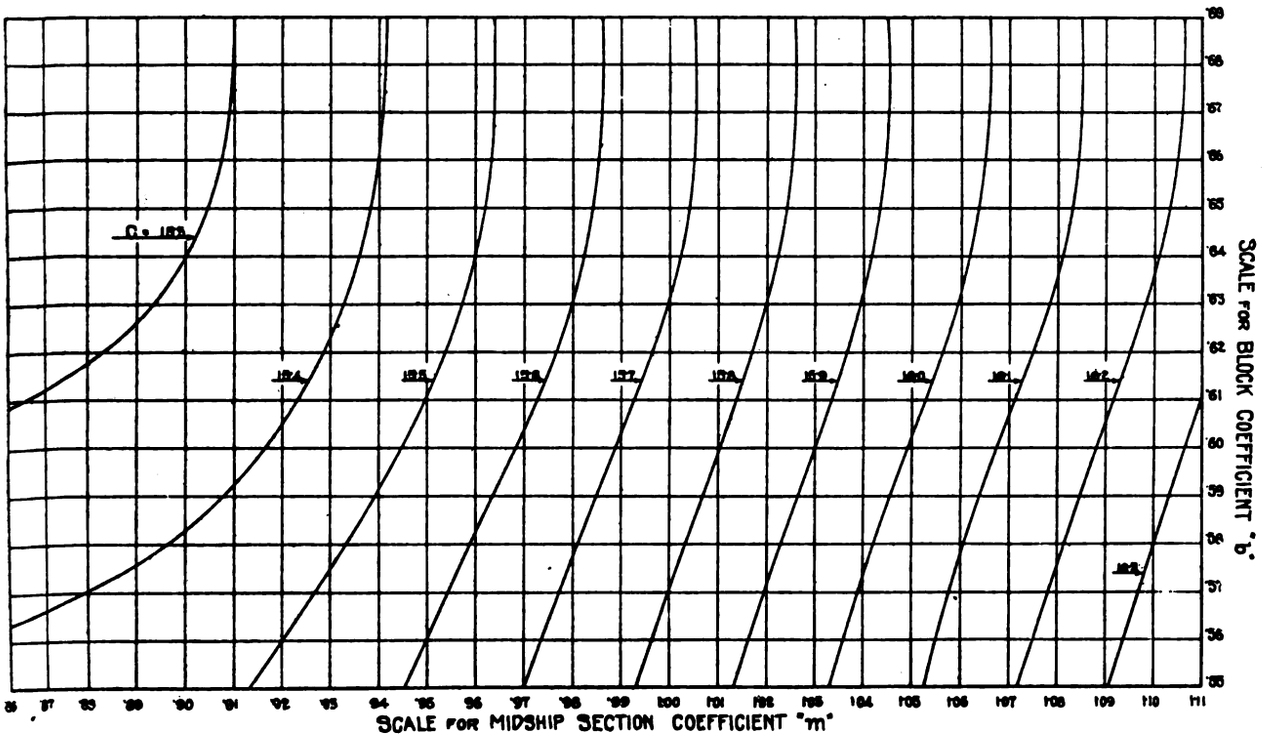

Fig. 3.—Contours of Wetted Surface Coefficient

The variation of C in Fig. 3 is as might be expected from what we already know of the effect of variation of form upon wetted surface. If we keep m constant and vary the block coefficient, b, there is very little change in the wetted surface; it decreases from $b = .55$ to about $b = .65$, but from .65 to .70 remains practically constant. If we keep block coefficient constant and vary the midship section coefficient there is appreciable variation of wetted surface for all blocks, the maximum for a range from an m value from .86 to 1.10 being about 6 percent. The fact that wetted surface coefficient diminishes from about 16.3 when m equals 1.10, to about 15.3 when m is equal to .85, or thereabouts, should not lead us to conclude that a smaller value of m will involve further material diminution in the wetted surface coefficient. As a matter of fact, 15.3 is very close to the minimum wetted surface coefficient obtainable, and if we continued to decrease m we would find the wetted surface beginning to rise again.

The 20 models were run in the usual way in the full depth

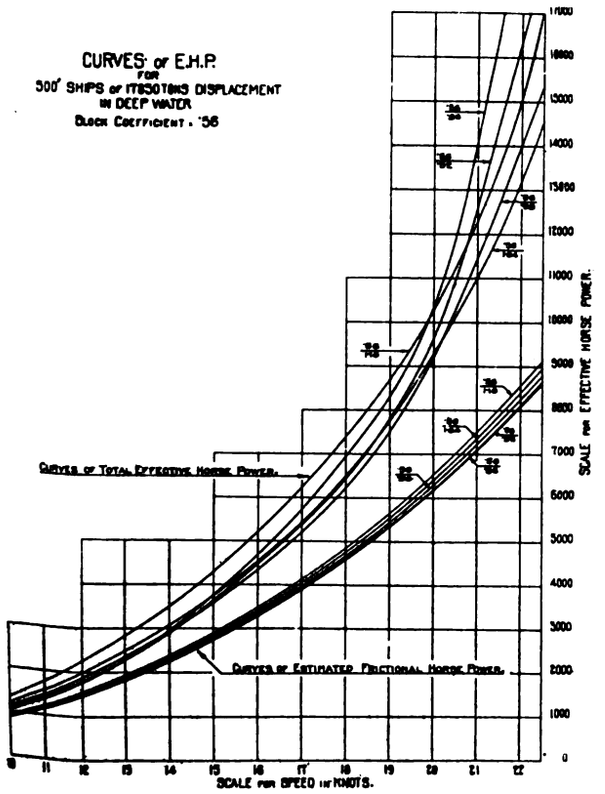
CURVES OF E.H.P.
FOR
300' SHIPS OF 17850 TONS DISPLACEMENT
IN DEEP WATER
BLOCK COEFFICIENT . 56
CURVES OF TOTAL EFFECTIVE HORSE POWER.
CURVES OF ESTIMATED FRICTIONAL HORSE POWER.
SCALE FOR EFFECTIVE HORSE POWER.
SCALE FOR SPEED IN KNOTS.

Fig. 4

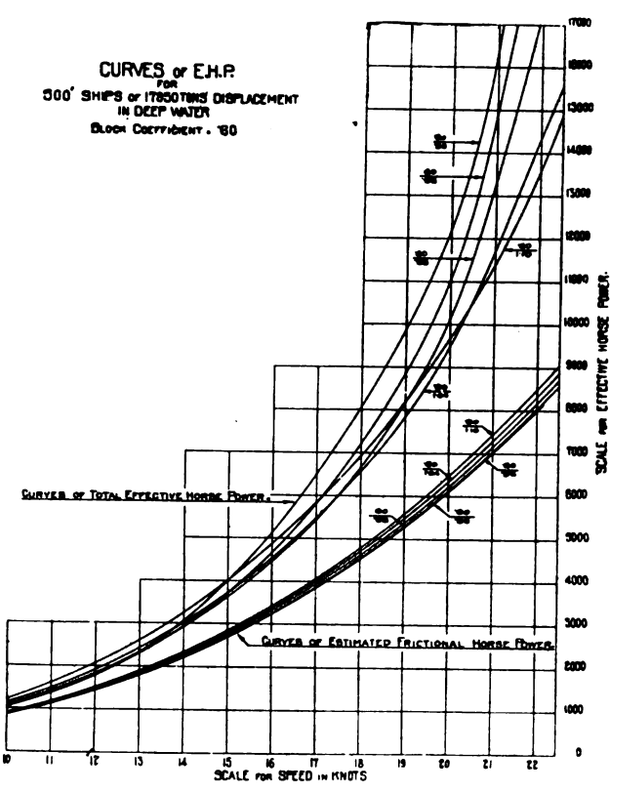
CURVES OF E.H.P.
FOR
300' SHIPS OF 17850 TONS DISPLACEMENT
IN DEEP WATER
BLOCK COEFFICIENT . 80
CURVES OF TOTAL EFFECTIVE HORSE POWER.
CURVES OF ESTIMATED FRICTIONAL HORSE POWER.
SCALE FOR SPEED IN KNOTS

Fig. 5

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of the model basin—14 feet in the center—and were afterwards tested, with a false bottom in place, in water 20 inches deep. The results are given in Figs. 4 to 12.

Figs. 4, 5, 6 and 7 give results as curves of effective horsepower in deep water for 500-foot ships displacing 17,850 tons upon the lines of the model. One figure is given for each block coefficient, the five curves in each figure referring to the five models of varying midship section coefficient.

It will be observed that except for very low speeds, where the smaller wetted surface associated with the fine midship sections has predominating influence upon resistance, the least effective horsepowers are found associated with the large midship section coefficients. In fact, for the vessels of large

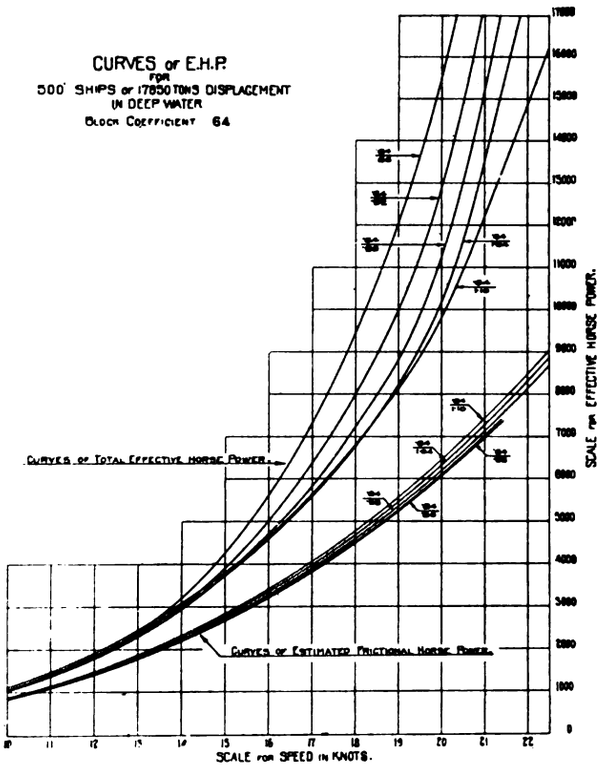
CURVES OF E.H.P.
FOR
500' SHIPS OF 17850 TONS DISPLACEMENT
IN DEEP WATER
BLOCK COEFFICIENT .64
CURVES OF TOTAL EFFECTIVE HORSE POWER.
CURVES OF ESTIMATED FRICTIONAL HORSE POWER.
SCALE FOR EFFECTIVE HORSE POWER.
SCALE FOR SPEED IN KNOTS.

Fig. 6

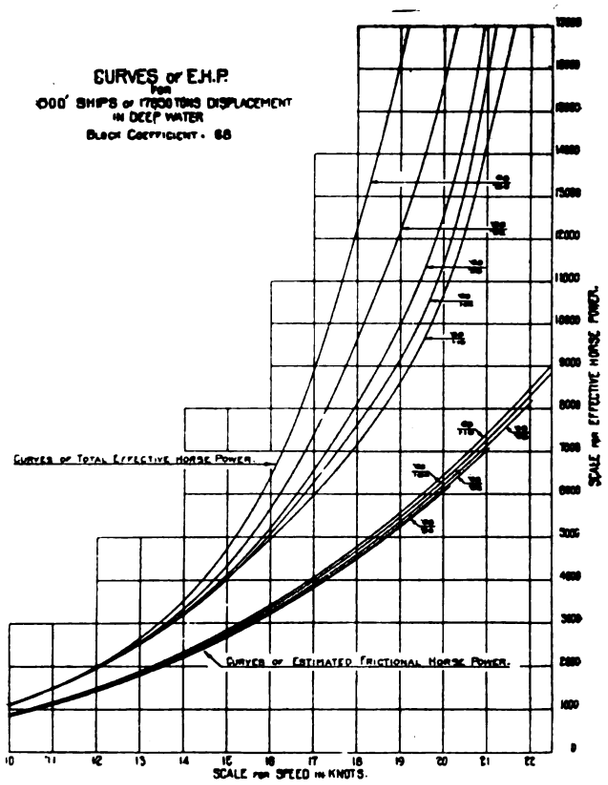
CURVES OF E.H.P.
FOR
500' SHIPS OF 17850 TONS DISPLACEMENT
IN DEEP WATER
BLOCK COEFFICIENT .68
CURVES OF TOTAL EFFECTIVE HORSE POWER.
CURVES OF ESTIMATED FRICTIONAL HORSE POWER.
SCALE FOR EFFECTIVE HORSE POWER.
SCALE FOR SPEED IN KNOTS.

Fig. 7

block coefficient less power would be required with midship section coefficients greater than unity. I think, however, we may safely say that the small powers found associated with the large midship section coefficients are not due entirely to the large coefficients. The larger midship section areas resulting from the larger coefficients enable us to obtain finer ended vessels, or vessels of finer longitudinal coefficient, and this more advantageous longitudinal distribution of displacement for the speeds at which tested helps to reduce the power.

I come now to shallow water results. The depth of water over the false bottom was 20 inches, while the draft of the models, as shown in Table I, varied from a little over 13 inches to about 15 inches, leaving comparatively small clearance under their keels.

It was found impossible to obtain consistent results for these models if they were run at speeds appreciably above three knots. At such speeds unstable eddies caused resistance for a given speed to vary radically. Accordingly these models were tested up to three knots only, and even then the results were materially more erratic than in deep water and required some cross-fairing of the experimental spots to make them consistent.

In Figs. 8, 9, 10 and 11 will be found shallow water results expressed as curves of effective horsepower for vessels 300 feet long, of 3,857 tons displacement, and in water 25 feet deep. Examination of these curves discloses the fact that in this shallow water the large midship section coefficients are at a disadvantage. Except for the highest block coefficient the curves of effective horsepower arrange themselves in order with the smallest midship section coefficient at the bottom.

There is another material departure from the deep water results. In deep water, broadly speaking, the finer the block coefficient the less the effective horsepower, but in the shallow water the effective horsepower at 10 knots, for instance, is very materially greater for the vessels having a block coefficient of .56 than for those having a block coefficient of .64.

The differences between deep and shallow water are perhaps more clearly brought out by Fig. 12, which shows curves of residuary resistance in pounds per ton plotted on

$$\frac{V}{\sqrt{L}}$$

Needless to say that the higher the curves for each block coefficient are for shallow water. The difference is quite remarkable.

I should like to explain the shallow water results, but this is almost the first systematic investigation which we have been able to make of shallow water resistance and I do not feel that the data so far obtained are sufficient to enable any final conclusions to be drawn.

It is obvious that the full-ended models run materially better in this shallow water than the fine-ended models. We know that for very high speed in deep water the same thing occurs, namely, that full-ended models are superior to fine-ended models. This is the case at, for instance, speed length ratios of 1.5 and over. It may be that in the shallow water the same type of form drives easiest at low speeds.

Another possible explanation is that in shallow water the shape of the midship section has the most material influence upon the resistance and that the low resistances associated

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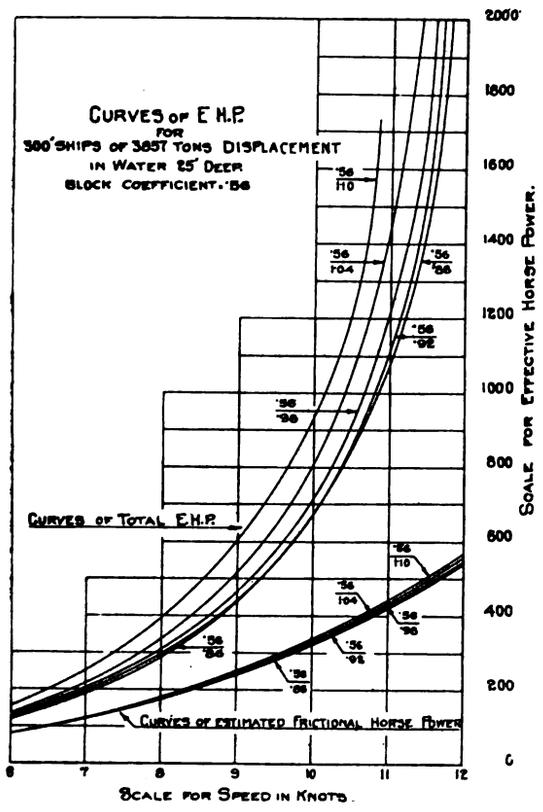
CURVES OF E.H.P.
FOR
300' SHIPS OF 3857 TONS DISPLACEMENT
IN WATER 25' DEEP
BLOCK COEFFICIENT. .56
CURVES OF TOTAL E.H.P.
CURVES OF ESTIMATED FRICTIONAL HORSE POWER
SCALE FOR EFFECTIVE HORSE POWER.
SCALE FOR SPEED IN KNOTS.

Fig. 8

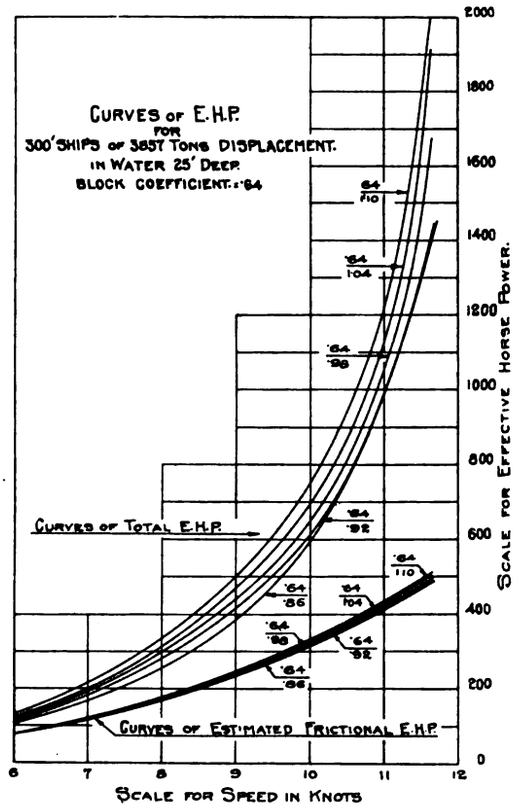
CURVES OF E.H.P.
FOR
300' SHIPS OF 3857 TONS DISPLACEMENT.
IN WATER 25' DEEP
BLOCK COEFFICIENT. .64
CURVES OF TOTAL E.H.P.
CURVES OF ESTIMATED FRICTIONAL E.H.P.
SCALE FOR EFFECTIVE HORSE POWER.
SCALE FOR SPEED IN KNOTS

Fig. 10

with the fine midship sections are due mainly to these fine sections and not to the accompanying full ends. If this is the case the coefficient of midship section has a different effect upon resistance in shallow water from which it has in deep water. My 1908 paper showed clearly that for the speeds we are now considering in deep water the full midship section coefficients were favorable to speed.

If I must venture one conclusion, which seems warranted

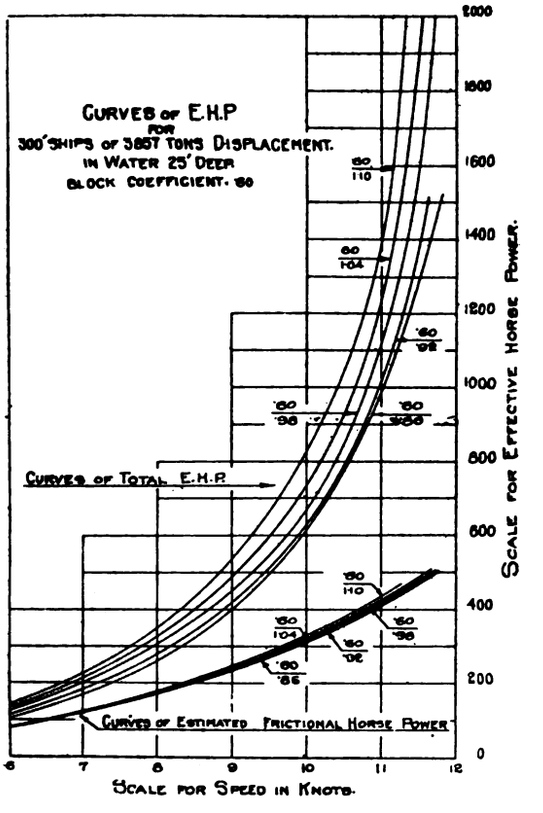
CURVES OF E.H.P.
FOR
300' SHIPS OF 3857 TONS DISPLACEMENT.
IN WATER 25' DEEP
BLOCK COEFFICIENT. .60
CURVES OF TOTAL E.H.P.
CURVES OF ESTIMATED FRICTIONAL HORSE POWER
SCALE FOR EFFECTIVE HORSE POWER.
SCALE FOR SPEED IN KNOTS.

Fig. 9

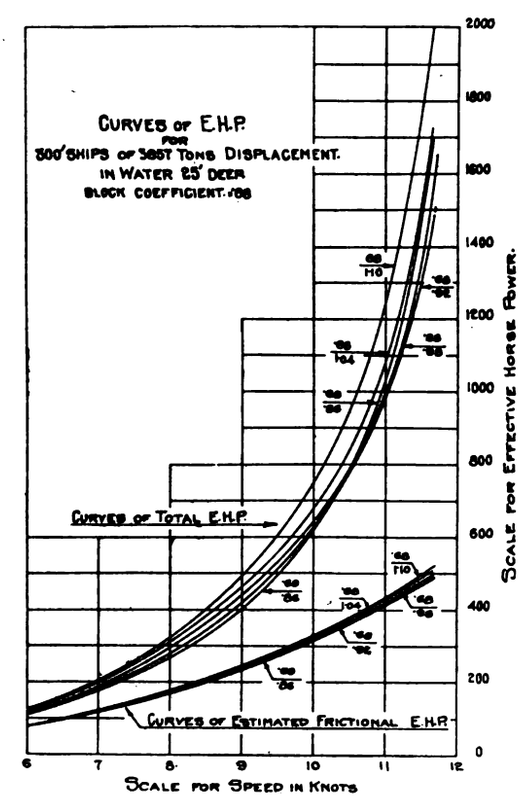
CURVES OF E.H.P.
FOR
300' SHIPS OF 3857 TONS DISPLACEMENT.
IN WATER 25' DEEP
BLOCK COEFFICIENT. .68
CURVES OF TOTAL E.H.P.
CURVES OF ESTIMATED FRICTIONAL E.H.P.
SCALE FOR EFFECTIVE HORSE POWER.
SCALE FOR SPEED IN KNOTS

Fig. 11

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by the shallow water experiments, it would be that unless for excessively shallow water there is probably no gain as regards resistance by adopting a midship section coefficient materially below .90.

It will be observed that even for the very shallow water in

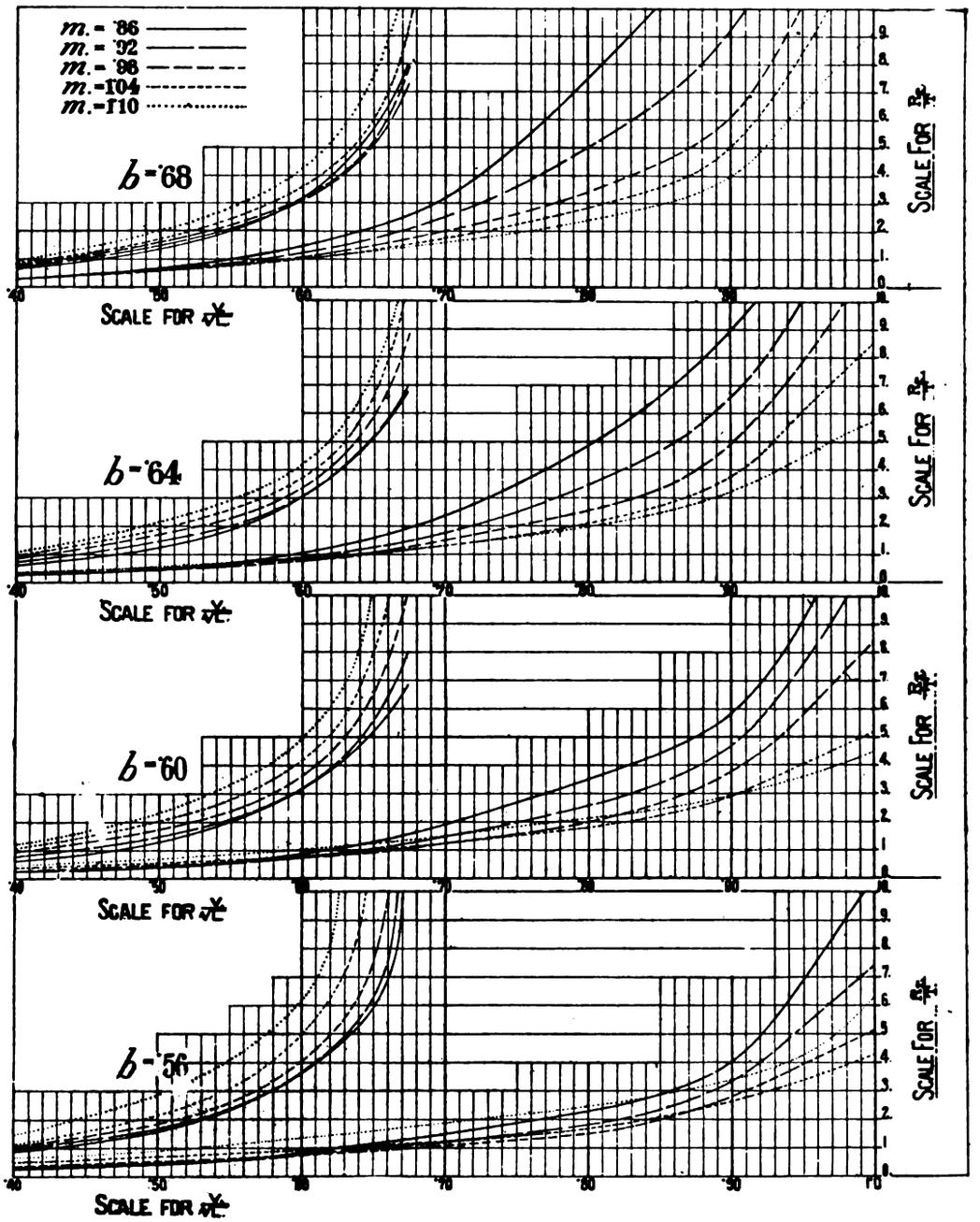

Fig. 12.—Curves of Residuary Resistance in Pounds per Ton of Displacement in Deep and Shallow Water

which these models were tested there was very little gain in dropping from midship section coefficient of .92 to one of .86. I would anticipate that as the water deepens the larger midship section coefficients would show a steady gain, and that for any depth of water greater than, say, 1¼ times the draft there would be no advantage from the point of view of resistance in adopting midship section coefficients below .90.

Pending systematic investigation of the features of form associated with minimum resistance in various depths of water it would seem that there are possibilities of great gain by careful model basin investigations of vessels of importance intended for shallow water work.

Obituary

Christian F. Olsen, naval engineer, for the past eighteen years in the employ of the Herreshoff Manufacturing Company, of Bristol, R. I., died Nov. 21 after a brief illness at his home in Bristol, aged 51 years. Mr. Olsen received his education at the Engineering Institute of the Royal Danish Navy in Copenhagen. His death is deeply regretted by his many friends in Denmark as well as in this country.

Samuel J. P. Thearle, D. Sc., chief ship surveyor of Lloyd's Register of British and Foreign Shipping, died at his residence, Croyden, Nov. 13, at the age of 67. Mr. Thearle was one of the early graduates of the Royal School of Naval Architecture. After several years' service as draftsman in the Admiralty he became a surveyor to Lloyd's Register of Shipping, becoming chief ship surveyor for them in 1909.

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McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER*

CHAPTER XVIII

Care and Management of Boilers

For several weeks there had been an enforced vacation in the Floating School, the reason being that the work of installing the new boilers on the *Tuscarora* had been rushed night and day in order to get the ship out in time for the heavy trade in the autumn months. The members of the school had been kept so busy that they had but little time for study, and Chief McAndrew, of course, had so much to attend to in the thousand and one details a chief engineer has to think of that he had no opportunity to give the young men any attention. The repair work was finally declared completed; a dock trial had been held and the new boilers found satisfactory. The ship was to sail early the next morning; O'Rourke and Schmidt had been given two hours' liberty, in which time they had taken a fond farewell of their Fishtown girls. Nelson and Pierce denied that they had any particular sweethearts in Philadelphia, but they had enjoyed their stay in that place so much that they were somewhat loath to leave.

A full crew had been shipped for the engineer's department, and the Chief had so arranged it that all of his pupils would be in one watch. Much to his gratification, Jim Pierce had been promoted to be an oiler. Gus Schmidt had been given a boost by being signed as a water-tender, which led O'Rourke to remark that it must have been because he was so fond of water. Nelson and O'Rourke were still retained as firemen, but the Chief had promised them that if they paid close attention to business they would be given the first vacancies as water-tenders.

The Chief, of course, having three assistants, stood no watch, and he very kindly agreed to continue his classes at such intervals while the four aspirants for licenses were "off watch," as it might be convenient for him to spare them a little of his time.

The ship proceeded down the Delaware River on her way to New York, and as the four young men stood the 8 to 12 watch, McAndrew said he would give them an hour or so of his time that afternoon. The school was quite a mystery to the other men in the engineer's crowd, and some of them were inclined to be a little facetious about the four "high brows," as they termed them. However, as information regarding the school was imparted to them almost simultaneously with an exploitation of the fact that O'Rourke had been awarded several prizes as a heavyweight boxer at an East Side resort, the tendency to sarcastic remarks rapidly dwindled.

On addressing his class that particular afternoon, McAndrew stated that as the ship was now at sea, and was to continue on her regular duties, he would take up the subject of the care and management of machinery, and naturally would begin at the boilers.

"Before starting fires under boilers," he said, "we must first examine everything connected with them. See that all stems on the stop valves, check valves and blow valves are oiled, and that the valves can be worked freely. The safety valve gear should be put in good working condition, and the valves raised slightly off their seats. The air cock at the top of the boiler should be opened, or if none such is fitted, open the top gage-cock in order to allow the air to escape. See that the grate-bars are all in place, that the damper works freely, that the handhole and manhole plates are set up tight, that all necessary fire tools are on hand, that the bunker doors are opened, and that the surface and bottom blow valves and drain cocks are closed tightly.

"If steam has not been raised on any of the boilers so as to allow the running of the pumps, the boilers should be filled by means of a hose from the deck, through the top manhole plates. It is only necessary to fill the boiler up to about two-thirds of a glass, as the water 'swells,' as the term is, when heat is applied to it. That is, in an ordinary boiler the water expands in volume as it is heated until it rises 2 or 3 inches in the glass. If no hot coals from another boiler are available, after throwing some coal on the bars, it is usual to start a wood fire at first and throw on a light covering of coal after the fire has commenced to burn freely. Soft coal catches fire comparatively easily, and so your fires will soon be burning in all the furnaces. In Scotch boilers great care must be taken not to force the fires and raise steam too quickly. It takes a long time to get the heavy shell plates warmed through uniformly, and if steam is raised too hurriedly the seams will begin to leak on account of the unequal expansion. For that reason it is usual to take from six to twelve hours' time in raising steam. One of the great advantages of watertube boilers is that steam can be raised rapidly without doing them any harm, as from their construction the water is rapidly circulated in all parts, and a uniform temperature throughout is easy to maintain. For that reason it is safe to raise steam in the average watertube boilers in a half hour if deemed necessary.

"The great disadvantage of all Scotch boilers is the large amount of water underneath the furnace which will not circulate naturally, and consequently remains quite cool even after steam is formed. To overcome this there are several patented devices which can be fitted to Scotch boilers, which will automatically circulate the dead water under the furnaces until the temperature is raised to very near that of the water above the furnaces. On ships which are not provided with such apparatus it is customary, if steam is available from another boiler, to run the auxiliary feed pump slowly, with its suction connected to the bottom blow, and its discharge entering the boiler through the regular feed pipe. This starts up a forced circulation and greatly facilitates the raising of steam.

"As steam begins to form slowly it will be first indicated by a slight hissing noise of the air escaping through the air-cock or the gage-cock. This air should be allowed to blow until clear steam can be seen escaping. Then the safety valves should be lowered, all cocks closed, and the steam pressure allowed to rise slowly, not over a rate of ten pounds an hour if there is no particular hurry about the operation. When the pressure rises to, say, 100 pounds, the auxiliary stop valve should be opened and steam admitted to the auxiliary line for the purpose of running the various auxiliaries.

"Having raised the steam to the working pressure, and put the boiler in service, the object of the engineer should be to keep it up to its highest state of efficiency; that is, to get out the most steam for the least expenditure of coal. To do this requires constant care and attention, for, like human beings, boilers respond readily to good treatment and rebel at harsh treatment. There are three principal things to do, which, if attended to intelligently, will keep a boiler in good condition. The first of these is to feed it with pure water; second, do not subject it to sudden changes of temperature, and, third, fire it properly.

"If these three maxims were lived up to there would be but little trouble. Unfortunately, however, they are difficult of accomplishment, and for that reason the average boiler is beset with many ills. Most of these arise from the quality of the water fed to the steel workman. In spite of precautions grease

* Engineer-in-chief, U. S. Revenue Cutter Service.

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will get in the feed water from the condensed steam; acids will be generated by the contact with the copper condenser tubes and feed pipes, and salt water will get in through leaks in the condenser tubes and pipe connections, and occasionally salt water will have to be fed to make up losses. It is these foreign elements in the feed water which make all the trouble."

"Yes," broke in O'Rourke, with a meaning glare at Schmidt, "and my father always used to say that it is the foreign elements that make all the trouble in this country."

"Is that so?" sarcastically replied Schmidt. "I'll bet it wasn't many days before you were born that he was tramping through Castle Garden himself."

"I don't suppose that any of us is eligible to join the Sons of the American Revolution," said McAndrew; "but that cuts no figure in this land of the free.

"As I was saying before being so rudely interrupted, if it were not for the impurities which get into the boilers the engineer would have but little trouble in keeping the interior surfaces clean. To counteract all these impurities is one of the main parts of an engineer's duty. Hence one of the first things to do is to ascertain how much salt water slips in from one source or another. Since steam vessels first plied the oceans, every one has been fitted with an instrument known as a salinometer—not 'salometer,' as I have heard O'Rourke term it. This word means literally salt measure, and at that it does not express its use correctly.

"Salt, of course, is one of the principal solids in salt water, but there are enough other chemicals in it to start a small drug store. In case any one ever asks you what salt water does contain you can refer to this analysis of the average sea water, as it contains the following parts in 1000:

Water	964.745
Chloride of sodium (common salt)	27.059
Chloride of potassium	.766
Chloride of magnesium	3.666
Bromide of magnesium	.029
Sulphate of magnesia (Epsom salts)	2.296
Sulphate of lime (plaster of paris)	1.406
Carbonate of lime (chalk)	.033
	1000.00

"Some chemists state that there is also a small quantity of gold in sea water; but I wouldn't advise any of you to buy any stock in a company formed for the purpose of getting gold from that source.

"Although the instrument I have referred to is called a salt measure, its real purpose is to determine how much solid matter is contained in the water. By adding up the amounts of all the solid ingredients in sea water you will see that they foot up approximately 1/32 of the entire weight of the water. That is, in 1 pound of salt water there would be 1/32 pound, or ½ ounce, of solids. Hence all salinometers are graded on that basis; 1/32 means salt water as drawn from the sea; 2/32 means twice as much solid contents as ordinary sea water, and so on.

"With every salinometer there is a small glass instrument weighted with shot known as a hydrometer. This instrument is usually graduated in divisions known as 32nds, which is based upon the principle that a floating body displaces an amount of water equal to its own weight. Hence the heavier or denser the water it floats in, the higher will be the portion out of the water. That is the reason that it is easier for a man to float in salt water than it is in fresh water. I have told you before that water expands when heated, hence its weight or density varies with its temperature. Therefore, to use the hydrometer correctly, the water to be tested must be at the same temperature for which the scale on the hydrometer is adjusted.

"On most hydrometers there are three scales shown—one at 190, one at 200 and the other at 210 degrees F. The method of testing is to open the cock and allow the boiler water to fill a brass vessel, known as the salinometer pot; if it is below 190 degrees F., as shown by the thermometer, admit sufficient hot water from the boiler to heat it up to one of the three temperatures shown on the scale. Then put in the hydrometer and observe how high it floats on the temperature scale corresponding to the temperature of the water. If you should hear some one say that the water is 2¼ or 2½, it would mean 2¼ thirty-seconds, or 2½ thirty-seconds, as the case might be.

"I have devoted some time to telling you about the salinometer and how to use it, but I will tell you very briefly that it is not of much value nowadays, as that method is too crude for modern usage. You might as well weigh drugs on a hay scale, so far as accuracy is concerned. There is in use on a number of ships a chemical process for determining accurately the amounts of the principal ingredients in boiler water; the apparatus is so simple that if the directions are closely followed any engineer can use it.

"Very few marine engineers allow salt water to be used for make-up feed in these days, hence it is not so essential to guard against scale-forming ingredients in the water. The principal causes of deterioration, such as rust and pitting, are due to the acids which get into the boiler water and thus encourage galvanic action."

"What's that?" blurted out O'Rourke.

"I thought you wouldn't understand it, O'Rourke, and so I used the term to arouse your curiosity. The word 'galvanic' is derived from the name Galvini, an Italian scientist, who first discovered that an electric current is set up by the action of one metal on another. You all probably know something about the ordinary battery used for generating an electric current. This consists of a glass jar in which are immersed pieces of zinc and copper; you have probably noticed that the liquid in which they are immersed is slightly blue in color, this being caused by putting in some crystals. The object of these crystals is to form sulphuric acid in which the chemical action between the copper and zinc is readily started, with the result that an electric current is generated; the further result is that the zinc is gradually eaten away by this action, and after a certain length of time has to be removed. Now if these two metals had been placed in a jar containing pure water there would have been none of this action taking place.

"Here, then, is the secret of boiler pitting and corrosion; the whole boiler, if the water is allowed to get in acid condition, becomes like an immense battery, or rather a collection of small batteries, as this action will take place between different parts of the steel of which the boiler is constructed as well as between a brass feed pipe and the boiler shell, only, of course, it will not be so rapid. Hence it is that for years past baskets containing zinc have been suspended in different parts of the boiler immersed in the water, as the zinc is much more easily attacked by galvanic action than are the steel and iron of the boilers. The zinc is therefore eaten away, and, theoretically at least, the various parts of the boilers are spared. Later investigations on the subject have developed the fact that even the use of zinc is not the best step to be taken, as that is simply remedying the effects without removing the cause. In other words, it is similar to trying to cure a headache for a drunken man after every night's jag instead of making him stop drinking the booze and preventing the headaches."

"I can understand that argument all right, all right," said O'Rourke, who had been, for him, paying very close attention to McAndrew's remarks.

"These later experiments which I refer to have been directed towards preventing the boiler water from getting into an acid condition, and thereby stopping galvanic action and rust. It is a well-known law of chemistry that alkalis will counteract or neutralize acids. Plain soda ash, or sal soda, as it is called commercially, is one of the best and cheapest of

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the alkalis obtainable, hence that is the material best used for counteracting acids in boiler feed water. It is also used to "kill" grease and oils which get into the feed water. Soda and zinc have for many years been relied upon to correct all of the evils which beset marine boilers, and yet they continue to rust, pit and eat away.

"By a long and continued series of tests recently held, some curious facts have been learned regarding the use of soda in feed water. One is that a small amount of soda, about one-tenth of 1 percent, is less corrosive than neutral water, or water that is neither acid nor alkaline; another is that water above one-tenth of 1 percent, and up to 2.6 percent alkaline, is really more corrosive in its effect than water in its neutral state. Finally, these experiments demonstrated that water containing 3 percent and over of the alkaline solution is absolutely non-corrosive.

"But the addition of so much ordinary soda to a boiler in which necessarily there are some oils or grease, will invariably cause violent foaming, or priming, as it is sometimes called. This is prevented by mixing with the soda certain proportions of glucose and a substance known as 'cutch,' which is a form of tannic acid. These ingredients tend to prevent foaming and the formation of scale. These materials are combined in standard makes of boiler compounds, and if they are properly used there is little doubt but that pitting and rusting will cease to a great extent. In order to get a 3 percent solution of the boiler water it is necessary to add about 5½ pounds of this compound for each ton of water in the boiler.

"Heretofore the care of boilers has been very much on the order of quackery in dosing the human system with all kinds of patent nostrums. There are but few medicines given by doctors which really accomplish any good, and they have been developed by experimenting. Many a good man has lost his life by having various kinds of 'dope' tried out in his stomach, and many a good boiler has met an untimely end by ignorant treatment. Now the 'boiler doctors' are really studying the subject, and from this time on boilers will be given better treatment. You young men are coming into the business at a time when the new methods of treating boilers are being perfected, and I predict that by the time you get in charge of steam machinery you will know much better how to take care of your boilers than engineers have in the past.

"No matter how well you treat the boilers while running they must, at certain periods, be given an overhauling, and at such times the greatest care and attention must be given them.

"The fire surfaces must be thoroughly cleaned and all deposits of soot brushed off. The water surfaces must be given the closest attention, and particular care taken to clean all dirt and scale off the crown sheets or tops of the furnaces. As you all know, this is no easy job, especially with Scotch boilers, as the spaces in which a man has to work are necessarily cramped, the air he breathes is vile, and there is every condition which would make him shirk the work, yet if the cleaning and scaling are not done properly the boiler and the coal pile will suffer alike.

"To give you an idea of the bad effect of even a slight amount of scale on the heating surfaces of a boiler, you will be surprised, I know, to learn that a hard scale only one-twentieth of an inch thick reduces the efficiency of a boiler 11.1 percent. That is, if a boiler is scaled up to that thickness on its heating surfaces, for every hundred tons of coal consumed there will be an absolute loss of 11.1 tons in the steam-producing effect."

"That would very nearly pay the fireman's wages, wouldn't it?" inquired Nelson.

"Yes, and more than pay them, so you can see the necessity for keeping boilers clean.

"Soot on the fire surfaces has almost as bad an effect, so you can understand how important it is to blow the tubes while running."

"The company ought to pay us extra every time we blow tubes," suggested O'Rourke.

"That's where you are wrong, as usual, O'Rourke. Employers in these days pay people to look after their interests in every way, and because a man is a fireman doesn't mean that he is for the sole purpose of shoveling coal in the furnaces. It is the fellow who thinks what he can do to save his employers money by keeping the particular piece of machinery which he is handling up to the highest state of efficiency who gets promoted and carries away the most coin on pay day.

"When cleaning boilers it is very important that all the valves and attachments be given a thorough inspection and put in first-class condition. All screw valve stems should be oiled with cylinder oil and graphite, glands repacked, safety valve lifting gear oiled and made to work easily. Small pin-head leaks should be touched up with a calking tool as soon as they are noticed. A leak in a boiler should be treated in accordance with the old saying, 'A stitch in time saves nine.'

"Many people have the idea that a fireman to be successful need only be sufficiently strong to stand the heat and shovel coal in the furnace for a period of four hours at a time. That is a great mistake, as the successful operation of marine machinery depends more upon skillful firing than upon any other part of the business. No man can be a successful marine engineer unless he knows how coal can be burned most efficiently, and sees to it that what he knows in that line is put into force by the gang in the fire-room. The average fireman if left alone to follow his inclination will nearly always fill up his furnaces to the top, under the mistaken idea that a 'crown-sheeter,' as it is termed, makes the most steam. The average fire-room watch will, if not instructed otherwise, as soon as they come on duty clean their quota of fires, usually about one of every three, fill up the furnaces, then sit down and smoke for an hour or so. The boilers will also smoke under such treatment and make about as little steam as possible.

"In order to get the best results the following rules should be stuck to closely:

"Carry the fires for natural draft not over 8 or 10 inches thick; if forced draft is used they should be about a foot thick.

"Put on only two or three shovelfulls at a time in each furnace—throw it on quickly and spread it evenly over the fire.

"Never open more than one furnace door at a time, and close it just as soon as possible.

"Never throw in any lumps larger than a man's fist; have the coal passer exercise himself by using a coal maul on larger lumps before putting the coal in the furnace.

"Only use a slice bar to remove clinkers or ashes, and to keep the fires bright from the under side.

"Keep the ash pans clear at all times.

"Clean only one fire at a time, and so regulate the periods between cleanings that they come regularly, if the coal is of uniform quality; otherwise clean them whenever they get dirty.

"If the draft is strong and the coal very fine and dusty, sprinkle a little water on the coal.

"Keep the fires of even thickness by the use of the hoe or rake; level them off every other time that coal is thrown into the furnaces.

"Have each watch get out its ashes before being relieved, otherwise there will be a scrap with the next watch.

"In general, have everything done in the fire-room with some snap."

"In other words," butted in O'Rourke, "put some ginger into the work."

"Yes, that's it; let the 'ginger-snap' be the motto of the fire-room."

"It's more likely to be the hardtack," suggested the Hibernian.

"That's true, too, unless you use your brains as well as your muscles."

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"Won't you tell us something about a water-tender's duties?" asked Pierce, who was feeling the responsibility of his new job.

"I was just coming to that," replied McAndrew. "The success of the fire-room depends largely upon the water-tender; the engineer of the watch may issue all the instructions about firing that he wants to, but he can't be in the fireroom all the time to see that they are carried out. Hence a rattling good water-tender is very necessary. Primarily he wants to be a man of nerve, quick to think and quick to act, and it's not a bad asset for him to be able to lick any fireman or coal-passer in his watch. Not that he should resort to tactics of that kind—far be it from me to suggest any such cruel procedure—but I have noticed in my several years of climbing that a water-tender who is handy with his fists generally keeps the ginger in the ginger-snap with his men. His principal job is to keep his mind on his duties during every minute he is on watch, and to keep his eye on the gage-glasses at least once every minute.

"He must also see that the furnaces are charged regularly in accordance with his instructions; that the fire-room is kept clean; that the coal is tallied; that the ash pans are hauled and the ashes blown out, and, in general, that all the routine duties of the fire-room are kept up. Ordinarily he should see that the water is maintained at about half a glass, and that the feed is so regulated by the check valves that it remains steady at that height if possible. As long as a boiler is under steam and the engines running, the feed should never be entirely cut off—no boiler has ever yet been blown up by having too much water in it, so there is no danger to the boiler even if you do put too much water in it—sometimes there is danger to the engine on account of foaming, caused by too much water. In general, the all-important thing to guard against in tending water is that there will always be water showing in the gage-glasses. Low water is the cause of 90 percent of all boiler explosions, and in nearly every case it is a direct result of carelessness.

"In case the water does get out of sight, as it will do at times in the best regulated fire-rooms, the first thing not to do is to get excited. No boiler ever has blown up immediately after the water has dropped out of sight. Keep cool yourself and try to cool the affected boiler. If you feel positive that the water level is only a little below the bottom of the glass, open the check valve wide and hold your breath. You may, during your first experience, think that it is taking about one month and ten days for the water to show up, but in reality it is usually visible in four or five minutes; then you can begin to breathe again. If, however, the water is out of sight, and you don't feel positive of the last time you saw it, close the damper; put up the ash-pit doors; shut off the main and auxiliary stop valves and the check valve and throw wet ashes or fresh coal over the fires to deaden them. Never haul the fires out until they have been deadened or extinguished by water, as stirring them up temporarily causes an increased heat, which might prove disastrous.

"In case of low water, the first thing, of course, is to try and remedy it by cutting out the boiler affected, as above described. But the water-tender must remember that the other boilers are still steaming, and he must not neglect to see that they are properly looked after, notwithstanding the temporary excitement on account of the crippled boiler. To sum it all up, a good water-tender must combine attention to business, quickness to act, and imperturbability of the highest degree."

This last qualification simply stunned O'Rourke, and while he was trying to recover from the shock the length of the word had given him, the Chief said: "I knew that would hold you, O'Rourke; but don't be alarmed, it simply means the quality of not getting rattled; you have your share of it.

"When the ship arrives in port and the boilers are to be out of use for several days, the fires should not be hauled, but simply allowed to die out gradually, so that there will be no sudden cooling of the boiler shell. It is usually advisable to give them a good blowing off from both the bottom and surface blows. After the steam is gone they should be pumped up full with fresh water, putting on a small pressure of 5 or 10 pounds to make sure that they are filled up. They should never be emptied by blowing off, as that causes too sudden cooling. If the boiler is to be cleaned the fires should be allowed to die out and the water pumped out after the steam has disappeared.

"If the boiler is to stand full of water for any length of time, the water should be made alkaline, so as to prevent corrosion as far as possible.

"If the ship is to be laid up great care should be paid to putting the boilers in such condition that they will not deteriorate. The grate-bars and furnace fittings, ash pans, etc., should be taken out and stacked up in the fire-room, out of the way but in a convenient position to be replaced. The interior of the furnaces, the combustion chambers and the tubes should be thoroughly brushed and cleaned to remove all soot and ashes. They should then be given a coating of black oil all over. The inside or water surfaces should be thoroughly cleaned and then thoroughly dried out by starting a light wood fire in the furnaces for a few moments, and by burning pans of charcoal inside the boiler. Some people prefer to fill the boilers up solid with water when they are to be laid up for several months, but I prefer to have them laid up dry as I have described. All the valves should be overhauled; put in good condition, and the valve stems coated with heavy oil or grease. A hood should be placed over the smokestack in order to keep the rain from leaking down and running into the up-takes.

"I could tell you lots more about the care of boilers, as you must remember that it is almost an inexhaustible subject. However, I have touched on the high spots of care and management, and you must learn much more by reading and from experience, the greatest teacher of all."

"They say old Experience is a hard teacher," suggested O'Rourke.

"You will find that he is if you don't follow the rules of his school."

"What are they?"

"His schools on board ship require diligence, energy and sobriety; if those three are lived up to you will find the old fellow is rather an easy teacher."

Launch of the French Liner Flandre

The latest addition to the fleet of the French Transatlantic Company was launched Oct. 31 by the Société des Chantiers & Ateliers de St. Nazaire (Penhouet) at their Atlantic yard. This vessel was christened the *Flandre*. She has been specially designed for the St. Nazaire-West Indies service and will be one of the most luxurious and speediest vessels on this service.

Contrary to the usual method of launching at the Atlantic yard, the vessel was launched on a single launching way. Her weight at the time of launching amounted to 3,800 tons. The total length of the stationary way was 499 feet and its width 40 inches. The sliding way was 414 feet 5 inches long and 36 inches wide, therefore the pressure on the ways at the time of launching was equal to over three tons per square foot. The declivity of the ways was 6 percent.

The main particulars of the vessel are as follows:

Length over all	480 feet 4 inches
Length between perpendiculars	459 feet 4 inches
Beam	57 feet
Depth to main deck	37 feet 1 inch
Draft, full load, aft	23 feet 8 inches
Displacement at load draft	11,330 tons
Gross registered tonnage	8,460
Designed speed	18.5 knots

A double bottom, divided into twelve compartments, hav-

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ing a total water capacity of 1,000 tons, has been worked from end to end of this ship. The hull is further sub-divided by ten watertight bulkheads and there are seven decks, four of which extend from the stem to the stern.

The propelling machinery is of the type especially in favor in this yard, and which has been used with marked success on the steamships *Rochambeau, Lutetia,* etc. The machinery consists of two triple expansion four-cylinder main engines, driving the inner shafts and exhausting into two Parsons reaction turbines designed for ahead working only, driving wing propellers. Steam is supplied by six single-ended furnace Scotch boilers working at a pressure of 200 pounds per square inch under Howden's system of forced draft. The boilers are arranged in two compartments, each boiler-room having a separate funnel extending 98 feet above the grate bars. The total heating surface of the boilers is 28,600 square feet.

The passenger accommodations are arranged as follows: On the main deck are the second and third class accommodations and also quarters for the engineers, firemen and servants. On the deck above are first class staterooms and the main dining room. On the promenade deck are first class staterooms and on the awning deck special suites, together with the first class social hall, smoking room and café. The officers are quartered on the boat deck.

Old-Time War Vessel on the Great Lakes*

BY NEIL WILBER** AND LANDIS ISAACS†

The paddle wheels are of the built-up type, 22 feet diameter with 16 wooden stationary paddles, 16 inches by 96 inches by 2 inches thick. There are three cast iron spiders keyed to the shaft with 3-inch by ½-inch steel bars bolting into them for carrying the paddles. They have the necessary rim bars and tie rods. There is also a brake and brake band on the inboard spider, for locking the wheels to keep them still for inspection or while at a dock in bad weather, to eliminate noise.

BOILERS

The *Wolverine* has two boilers of the leg type. These were installed in 1892, and up to the present time have given no trouble whatever. The first boilers installed in the *Wolverine* at the time the vessel was built lasted fifty years, and were replaced by the present boilers. The first boilers were, so to speak, half-and-half, because they were part watertube boilers, as shown in the sketch, Fig. 12.

This sketch also shows the peculiarities of their construction. There is a long furnace extending the full length of the boiler with a combustion chamber at the back. The gases of combustion return to the stack on the outside of a series of tubes through a square flue. The tubes extend across between two plates in the flue, the flue being entirely surrounded by water. It will be noted that this arrangement provides ample steam space in these boilers. There was also a drum that encircled the stack which acted as a superheater. The coal consumption of these boilers was about 2 tons per hour.

The present boilers were built for a working pressure of 25 pounds per square inch, and are still working at that pressure, although they are inspected annually. The coal consumption of the present boilers runs about one-half ton per hour. Fig. 13 shows the construction of these boilers. The design, by the way, was approved by the late Rear Admiral George W. Melville, formerly engineer-in-chief United States Navy. These boilers are of special interest owing to the low-pressure for which they were designed, and the thickness of plates, staybolts, etc., in comparison with the practice of to-day. The principal dimensions of these boilers are as follows:

* Concluded from the December issue.
** Ensign N. F. P., Acting Chief Engineer.
† Formerly Ensign N. F. P. and Chief Engineer.

Inside width of furnace	3 feet 6 inches
Length of grate	6 feet 6 inches
Grate surface, one boiler	45.5 square feet
Heating surface, tubes	980 square feet
" " flues	100 square feet
" " furnace	91 square feet
" " flue sheets	10 square feet
" " comb'tion chamber.	105 square feet
Total for one boiler	1,286 square feet

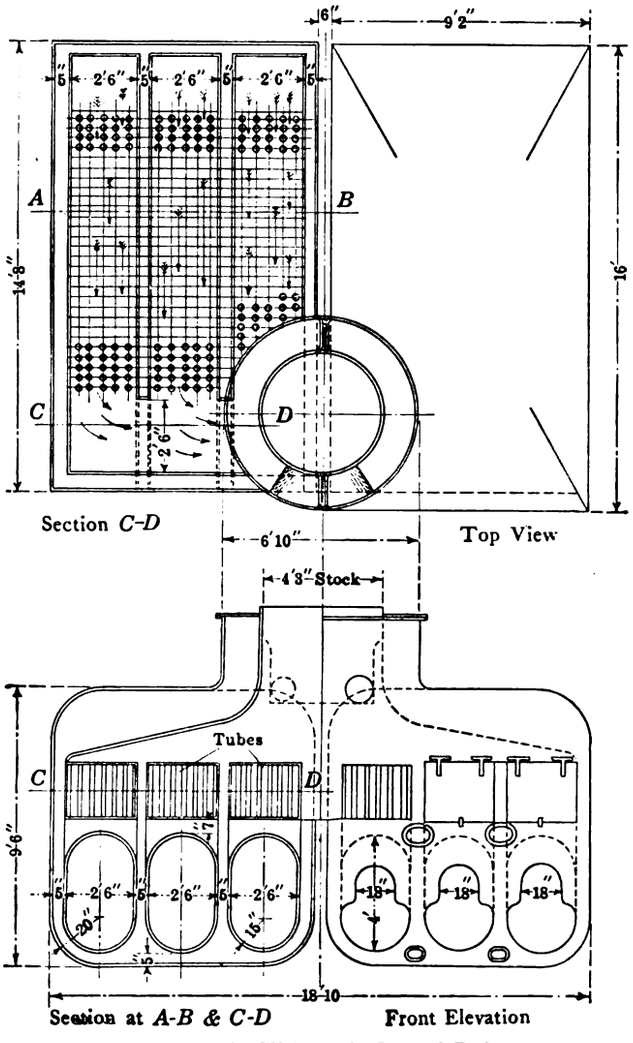

Fig. 12.—The Wolverine's Original Boilers

Ratio of heating surface to grate surface	28.26
Calorimeter	5.93 square feet
Ratio of grate surface to calorimeter	7.69
Number of tubes	78
Boiler pressure	25 pounds

All seams are single riveted except the longitudinal joints of the shell and of the steam drum, which are double riveted.

There is a steam drum built around the stack which serves as a superheater, so it is evident that even in the early days the engineers have given the question of superheated steam serious consideration. It is also evident that this question has been considered to a certain extent when the original boilers for the *Wolverine* were built, as shown by the drum around the stack in Fig. 12.

Superheated steam, of course, is being used to a considerable extent, and to considerable advantage in the navy to-day, although it has its disadvantages. In the case of the *Wolver-*

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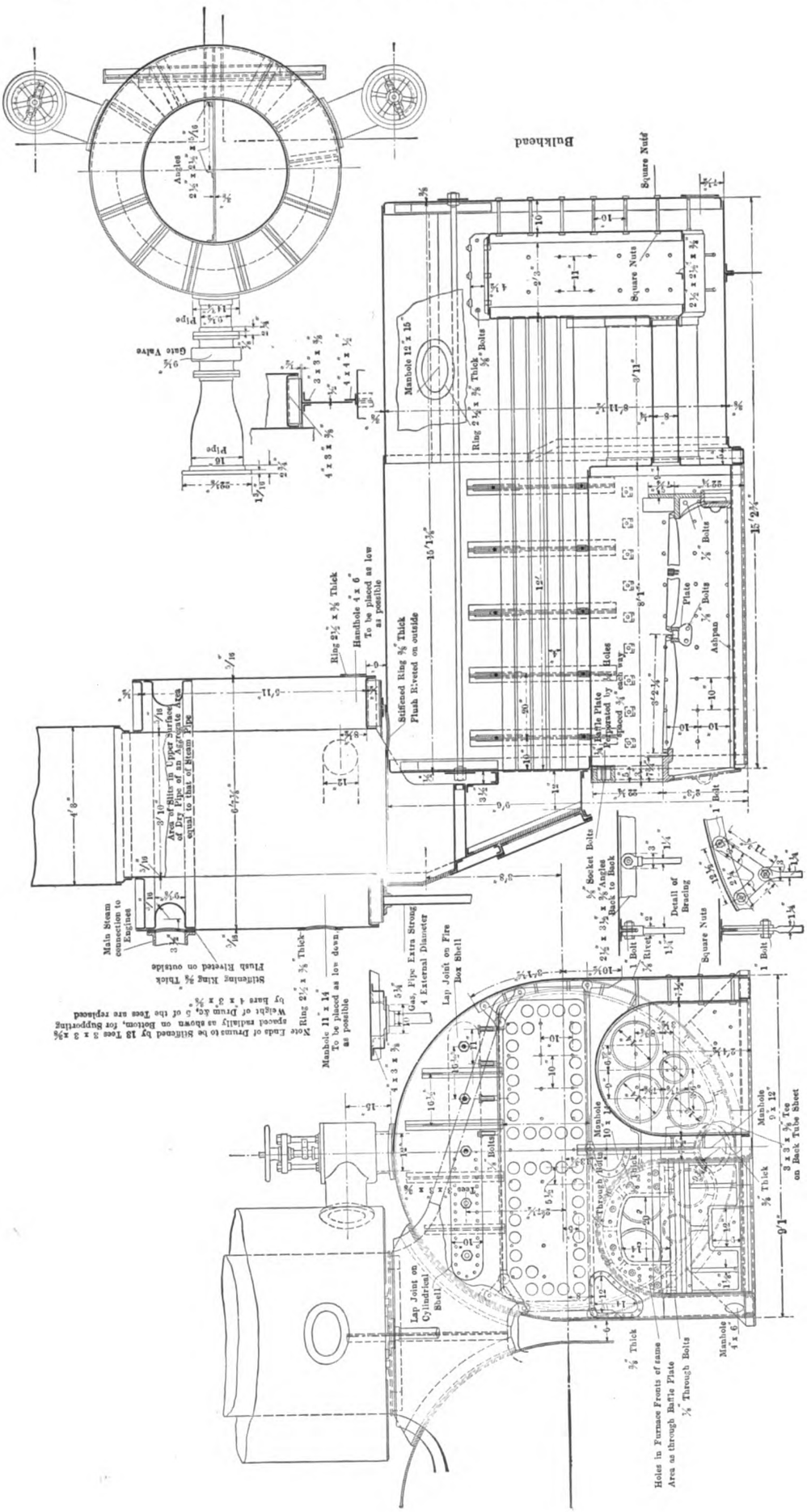

Fig. 13.—Details of Boilers Now Installed on the Wolverine

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ine, the steam can be shut off from the drum by the valves shown on the side of it. The valves, as shown on the drawing, have been replaced with a valve that has a side outlet to which a safety valve has been attached. There is also a safety valve on the top part of the drum. All three valves connect to one common copper pipe and discharge into the port wheel-house.

The boilers are set in cast iron saddles, which are bolted to the keelsons. The keelsons, by the way, are the same under the boilers as under the engine; in fact, they continue through the machinery space from bulkhead to bulkhead. In the bilge, under the boilers, about 3 inches of cement has been placed, as the plates showed a little weakness at that point, and it has been found that the cement has decidedly strengthened the

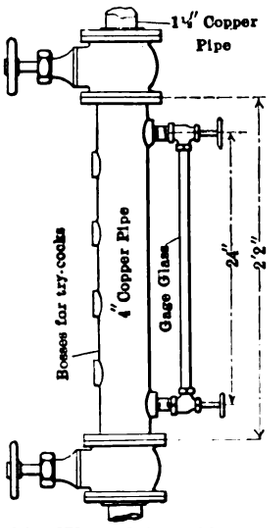

Fig. 14.—Water Column Now in Use

plates. The cement has now been in place for several years, and has proved very satisfactory for this purpose.

Pumps and Deck Machinery

The boilers are fed from the air pump when running and by a Doctor pump when not under way. The Doctor pump is the one originally installed when the ship was built, and works very well. This pump, though peculiar in its construction, is yet very simple, and by giving it steam and giving the fly-wheel a twist, it will start up without further ceremony. It is so arranged that you can pump from the sea, bilge, hotwell and tanks to the boilers or overboard. There is also a Blake horizontal double-acting pump, which can be used for the boiler feed, fire main, decks and sanitary system, etc. This pump is also connected to the bilge, hotwell, etc.

Aft of the engine room bulkhead is a large auxiliary hand pump, which is used for pumping from the bilge in case of fire or emergency, and is worked by hand levers on deck. This pump has an 8-inch connection to the bilge. There is a steam winch on the main deck forward for hoisting anchors and other deck gear. It has a small inverted compound engine, which works through a worm and worm shaft. This winch was evidently installed at the time the ship was built.

Generator

Light for the ship is furnished by a small direct-connected generator. There was some difficulty in getting an engine that would run at dynamo speed on this light boiler pressure, but finally, in 1905, a special engine was constructed and placed on board, which furnished a current at 110 volts. For sixty-two years the only lights aboard the *Wolverine* were kerosene (paraffin) lamps and lanterns.

Main Steam Pipe

The main steam pipe is copper, 15 inches diameter, and is attached at the highest part of the steam drum, which is up in the crank room or on the main deck above the engine and fire-room. There is a brass angle valve, with outlet turned down, to which the pipe is bolted. It extends down to the lower engine room and turns aft, and connects to the engine's steam chest through a 15-inch copper tee. Both outlets on the tee, or where they connect to the steam chest, are 15 inches diameter, or of the same size as the main steam pipe from the boilers. The tees also contain the butterfly throttle valves for the main engine.

In handling the engines two men are required, although three would be better, as the two have their hands full. Telegraph signals to engine room have been installed during the last few years. She is also supplied with a revolution counter

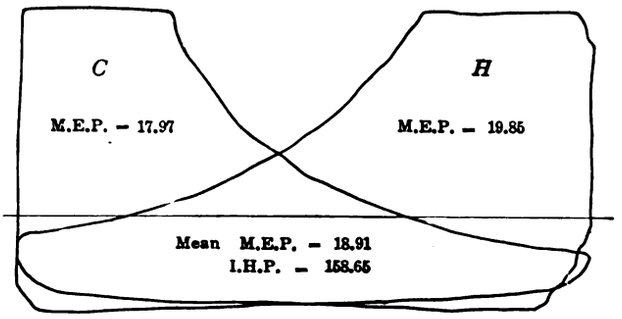

Fig. 15.—Indicator Cards from Starboard Engine. Pressure, 22 Pounds; Vacuum, 27 Inches; R. P. M., 17

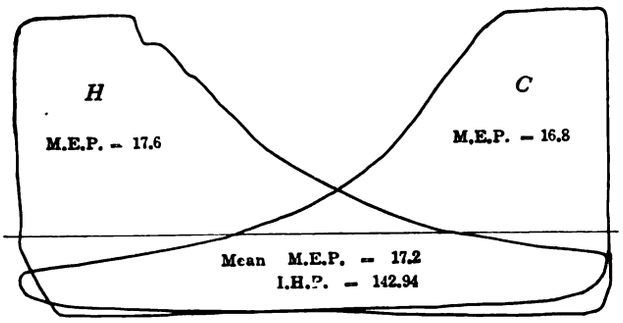

Fig. 16.—Indicator Cards from Port Engine. Pressure, 22 Pounds; Vacuum, 24 Inches; R. P. M., 17

and oil system worked by the engine, which is original, and also compression grease cups on the main bearings and connecting rods.

The boilers are so closely fitted in the space it is hard work to give them the necessary attention they should have, especially the accessories on same. The stringers, or gallows frame, continue on to the bulkhead forward of boiler, and it was cut away considerably in order to get the present boiler under them. The check valves and water column and other fittings are rather antiquated, but still serve the purpose well.

General Notes

The *Wolverine* is a little too large to permit of her being taken to the ocean, as she will not pass through the locks. She is remarkably steady in a seaway, and takes on but little sea, owing to a very high bulwark and to' gallant forecastle. She is a trifle mean to handle in windy weather about docks, as she doesn't draw much water, and the wind will "kick" her around quickly if the helmsman is not onto the trick.

Former records show that the *Wolverine* never made more than 10 knots' speed in regular service. At the time of the assassination of President McKinley she was in the harbor at Cleveland, Ohio, and upon being ordered to Buffalo, with all possible haste to prevent a riot, the safety valves were weighted, and they were able to get 30 revolutions out of the engines at one time during the trip. This gave her a speed of about 14 knots.

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The naval militia was very fortunate in securing this old ship, as she is roomy and well adapted for just the purpose for which she is used, and the citizens of Erie felt they could not part with her owing to the number of years she had been a part of the city, so to speak.

The Ohio militia made some drastic efforts to secure her for their State for the same purpose, but the city and surrounding country got together and formed two divisions, consisting of about 200 men, not including officers, and that was about the necessary allotment that was necessary to keep her in the State of Pennsylvania, and about six to eight months after same had been formed she was turned over to the State of Pennsylvania by the United States Government for training purposes. During the summer months the boys spend their week-ends aboard her, where they have the use of boats and tackle and also have their food.

The object of this article is not to advance any "new ideas" in marine engineering, only to show, if possible, the progress which has been made in the last half century through scientific, theoretical and practical application of principles by comparing the engines of the *Wolverine* to the latest battleship of to-day.

Indicator Cards

The indicator cards shown in Figs. 15-16 are cards taken this year on the *Wolverine's* first trip out after having been laid up all winter. The cards indicate a slight leak in the valves, but this wavy line very often happens to be caused by the valve rebounding after it is first seated and admits a little steam which shows up in the expansion line. The cards give the necessary data. The approximate clearance, as near as it can be arrived at from the cards, seems to be about 5 percent of the piston displacement.

The indicated horsepower, worked out from the cards shown with slide rule, is as follows:

$$\text{Indicated horsepower} = \frac{\text{PLAN}}{33{,}000}.$$

Port engine, indicated horsepower

$$= \frac{17.2 \times 8 \times 1017.9 \times 17 \times 2}{33{,}000} = 144.3 \text{ I. H. P.}$$

Starboard engine, indicated horsepower

$$= \frac{18.91 \times 8 \times 1017.9 \times 17 \times 2}{33{,}000} = 158.65 \text{ I. H. P.}$$

Total for both engines $= 144.3 + 158.65 = 302.95$ indicated horsepower.

Where P = mean effective pressure.
L = length of stroke in feet.
A = area of piston.
N = revolutions per minute.

The approximate steam consumption of the engines, calculated from the indicator cards (steam pressure from card), is as follows:

Steam consumption, port engine,

$$= \frac{1.8 \times 2 \times 17 \times 60}{144.3} = 25.44 \text{ pounds per hour per I. H. P.}$$

Steam consumption, starboard engine,

$$= \frac{1.8 \times 2 \times 17 \times 60}{158.65} = 23.15 \text{ pounds per hour per I. H. P.}$$

The above computation gives only the approximate steam consumption on account of leakage of valves and initial condensation of steam in the cylinder. The actual consumption is somewhat greater.

Coal Consumption

The two boilers when carrying 20 to 25 pounds of steam and under way consume about one-half ton of coal per hour, the coal being the best grade of Pocahontas.

The average of 140 pounds per knot brings the evaporation to about 6.17 pounds of water per pound of coal as fired.

A New Method of Stapling

BY EDWIN B. WHEELER

What is known as water or oil-tight stapling, coming under the head of anglesmith work in shipbuilding, is undoubtedly the most troublesome and expensive member of the structural family which forms the finished hull. I believe it can be safely stated for all practical purposes that anglesmith stapling, bolted in place ready for riveting, costs the American shipbuilders close to 30 cents (1/3) per pound for labor alone. With shipbuilding shapes from which the staples are wrought costing the purchaser about 2½ cents (0/1¾) per pound, something seems to be wrong.

Taking our market price for "shapes"—2½ cents (0/1¾) per pound—into consideration, what does this represent?

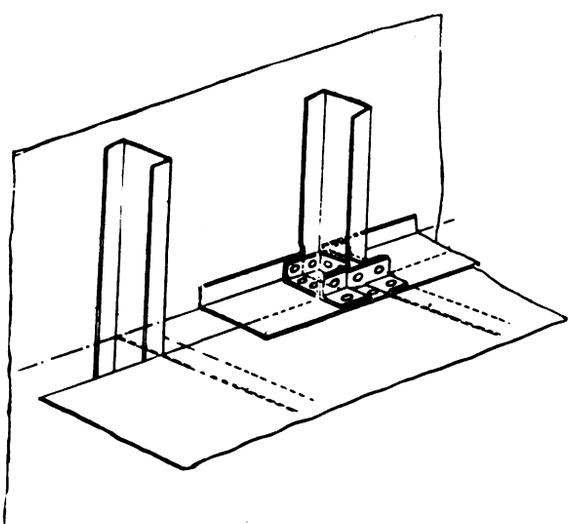

Fig. 1.—Angle Intercostals and Independent Staple

Roughly speaking, it covers the mining of iron ore, numerous handlings, smelting, furnacing, rolling and shaping, to which overhead charges and profit must be added. Something still seems to be wrong, judging from the above comparison.

The shipyard mechanic turns his part of the work out as fast as human hands will allow, and even with care and good workmanship in busy shipyards a considerable percentage of stapling work is scrapped each year, due mostly to cracked welds after bolting up or riveting. It appears that the above mechanic is asked to perform an impossible task in building the anglesmith stapling in common use for figures approaching the cost of other structural parts.

There is no doubt that in certain locations on ships, and in some designs of vessels, the anglesmith staple is a necessary evil, but of late years, especially, our largest and most important vessels, the battleships, for instance, have grown larger and larger, requiring more bulkheads, both longitudinal and transverse, as well as decks and watertight flats, necessitating increased amounts of water or oil-tight stapling work. About 75 percent of this stapling is dead flat, or nearly so, and can be constructed without anglesmith labor and with very little assistance from the shipfitters, whose combined efforts cost the shipyard the bulk of 30 cents per pound, above referred to.

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The accompanying sketches give the principle upon which this 75 percent of stapling could be constructed in a more economical and far less complicated manner. Other dead flat work is not furnaced, twisted, welded and then brought back to its original section before placing in the ship, at least not in the shipyard, for one of the main ideas of good modern designing is to so shape the construction of a vessel that the minimum of furnace work is allowed to creep in, so why treat the bounding bar to all of this unnecessary attention that is so expensive?

It will be noted that this design of construction allows the employment of a universal system, and therefore could be turned out along with decks and bulkheads to take its place directly upon the erection of structural parts. This point alone is of inestimable value, as with the stapling in general use all structure in the neighborhood of joints to be collared must be in place and trued up before work on the bounding bars can be

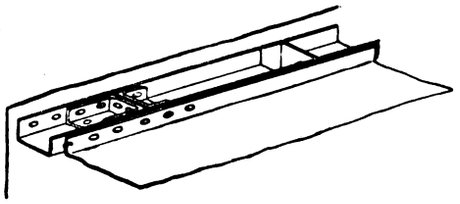

Fig. 2.—Channel Intercostals

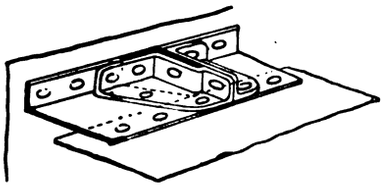

Fig. 3.—In Way of Angle Bar

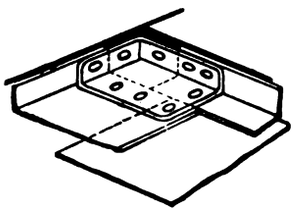

Fig. 4.—At Bulkhead Corner

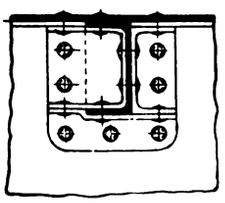

Fig. 5.—With Flanged Deck or Bulkhead Plating

commenced, causing delay in testing of compartments and in the final delivery of the ship as well.

Touching upon the practical points of the universal staple, the intercostal shape should be cut a trifle longer than the space it is intended to fill. This is to allow for the come-and-go of the frames from their original stations, the toe of frame, beam or stiffeners to be chipped away where found necessary. The flanged boxes and face clip offer simple pressing operations in their forming, and would surely not cost more than a small fraction of the stapling now commonly employed.

Just how far the independent staple and intercostal plate construction could be carried into beveled work before it would approach the cost of anglesmith stapling, only actual working conditions can tell. One thing strongly in favor of its use, however, away from the dead flat, is that though new dies would be needed to press beveled boxes, they could be called new for only the first ship or two, as the same bevels occur over and over again on all ships, though possibly at different stations. The same rule will hold good should the collars be made from cast steel, as in this case the original pattern takes the place of the die, and so far as different shapes or sections to be stapled go, there are but a few in general use, and they are all adaptable to this method, which offers undeniable advantages for dead flat or slightly beveled work, and is bound to bring the cost of this detail of ship construction into closer comparative relations with other members of the structural family.

Structure of Vessels as Affected by Demand for Increased Safety*

BY WILLIAM GATEWOOD

In view of the general interest which has been taken recently in the subject of safety of travel by water, culminating in an International Conference on Safety at Sea, it was thought that a short paper in the Transactions of this Society touching on some of the problems involved would not be amiss.

The dangers of the sea in times past were so great that a safe return from a voyage was a subject of public thanksgiving. It is still so considered by many; but the progress in the arts of shipbuilding and navigation, and the safeguards provided in the way of lighthouses, etc., have rendered travel by water actually safer than travel by land.

There is, however, at the present time a demand for greater safety, and this demand for increased safety is natural, and is the indirect result of the advance in civilization. Human life was never considered so precious as at the present time. Look at the prominence now given to the prevention of disease, and compare it with conditions which prevailed a century or two ago. Look at the Peace Conferences and Disarmament Plans, at the Employers' Liability Laws, and even at the courts, which are loath to condemn even murderers to death unless they are hardened criminals.

The natural tendency of the general public after any calamity involving great loss of life is to forget that absolute safety is impossible of attainment, and that the progress on which we pride ourselves cannot be made if the handicap is imposed that no risk of any kind shall be taken. The precautions which should be taken in any undertaking depend in great measure upon the disadvantages which are incurred concurrently with the precautions taken. For instance, if to insure the saving of one-half of the loss of life which occurs annually on our railroads it were necessary that all passenger and freight trains should run at half speed, the public would not stand for the change, as the effect on the business and private life of the country would be considered intolerable.

Further precautions in connection with the safety of vessels would seem advisable then only where they do not interfere so seriously with the present methods of conducting business and pursuing pleasure as to be considered a detriment to progress. The unsinkable vessel must be commercial or it will find no place in the merchant marine of this or any other country. The problem that is presented at the present time is, therefore, to build vessels which shall be as safe as it is possible to make them, consistent with the requirements of their trade. In other words, if further precautions in the building, navigation and upkeep of vessels for the purpose of promoting safety

*A paper read before the Society of Naval Architects and Marine Engineers, New York, December, 1913.

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are to be taken, they should be along such lines and so limited in extent that the commercial success of the vessels is not jeopardized. As the safety of vessels is a matter which is not apparent to the general public, it seems proper that it should be made the subject of national or international regulations as far as regulations can conduce to increased safety.

The dangers against which precautions should be taken in connection with the structure of a steel vessel may be classified as follows: Leaks, storms, ice, grounding, collision and fire.

LEAKS

Intact outside plating to above the water surface is such a common feature of new steel vessels that no comment on this subject is needed, except, perhaps, that the Government should require that the outside plating of old vessels should be subject to examination at intervals and should be kept up to a certain standard of strength and tightness, and that underwater openings should be properly protected.

STORMS

The precautions against storms should include the elements of strength, watertightness, stability and control.

Strength.—The rules of the classification societies are based partly on experience and partly on theory, and in general may be said to provide ample strength of structure. Indeed, there are many instances of vessels in service which have scantlings much below the standard of the classification societies, and which have shown no signs of weakness. It is generally accepted that if this matter is covered by legislation in this country a suitable method would be the assignment to every vessel of a maximum load line, which should be determined from a consideration of the scantlings of the vessel and her route in service. It is suggested that this maximum load line could be lowered as the age of the vessel increases, in a similar manner to the reduction of pressure on a boiler, to allow for deterioration. The stresses in the structure of a vessel seem to increase rapidly with increase of draft and displacement, and although the amount of the stress would depend on the shape of the vessel and the distribution of the cargo and other weights, it is considered that no fairer method of obtaining the measure of precaution as regards strength of structure to weather storms can be devised than by what is known as the assignment of freeboard.

To illustrate the effect of increase in draft the case is presented of an oil tanker, 389 feet by 49¾ feet by 30 feet. When loaded to a draft of 20 feet, displacement 8,720 tons, the compressive stress in the upper deck figures out at 6½ tons per square inch in hollow of wave 385 feet by 19¼ feet. When loaded to a draft of 24 feet 3 inches, displacement 10,705 tons, the corresponding stress increases to 9⅛ tons per square inch, or an increase in stress of 40 percent for an increase in draft of 21 percent.

Freeboard must also be considered in connection with stability and in case of damage.

Watertightness.—Under this heading would come not only the tightness of the underwater plating, but also the tightness of the plating above water, of the decks and erections, and of the openings in the sides, decks and erections. No special precautions in addition to those usually taken would seem necessary except the prohibition of the use, while under way, of openings which would be submerged in damaged condition.

Stability.—This is affected so greatly by stowage of cargo, etc., that a vessel which has a large measure of initial stability leaving port may have no margin of initial stability at the end of the voyage. Indeed, the introduction of water ballast is not an uncommon expedient adopted on many vessels to compensate for the fuel used. Some very successful vessels are unstable when light, and have ample stability when loaded. To provide for a proper amount of stability by legal enactment would seem almost impossible, especially if possible damage is considered.

As illustrating the difficulty of making any regulations regarding the stability, there is instanced the case of a passenger steamer which, while light, was sunk in shoal water as the result of a collision. The openings were patched and the vessel was ready for pumping out, when the question arose as to what was likely to happen during the process. Curves plotted for the ship "without ballast" show that the vessel would have been stable when first afloat at 30-foot draft, but would have become unstable as more water was pumped out and the draft was reduced to 18 feet or less. It was decided, therefore, to put ballast on board, as low in the vessel as possible—some 476 tons were added—and the corresponding curves "with ballast" indicate that under such conditions there was no lack of initial stability at any intermediate draft. That the vessel would have so large a measure of initial stability in this condition, with the holds and machinery spaces flooded, was hardly to be expected. Some photographs were taken of the vessel just after the collision, and the large list at one stage of sinking indicates that without ballast the lack of stability was far from being imaginary.

Control.—Suitable steering gear is so necessary that considerable attention is given to the subject in the design of all vessels. While accidents due to lack of control are frequent, it is doubtful whether anything would be gained by any departures from the recognized appliances.

Cases of loss of control of a vessel by derangement of the machinery are not infrequent, but are so much less frequent than formerly that this particular advantage claimed in former years for twin screws is nowadays not much discussed.

ICE

Special provision is made in the structure of vessels which are expected to run through ice by means of special framing and plating forward near the water line. Contact with icebergs is a special case of collision, or, as in the case of the *Titanic*, it may be described as a case of side grounding.

GROUNDING

This is one of the most common dangers from which vessels suffer. In many cases, when the ground is soft, no serious damage is done. But it does not seem feasible to design a vessel so that the bottom plating shall not be punctured or the stern frame broken when the conditions are not so favorable. The amount of leakage into the vessel can be reduced by subdivision into watertight compartments, and the problem which is presented is how best to effect sufficient subdivision without too much cost and without interfering with the service of the vessel. The fitting of an inner bottom for the purpose of storing water for feed or ballast and recently for the stowage of oil fuel, serves as the most desirable type of subdivision. As bottom damage often extends to the bilge beyond the limits of the standard double bottom, the extension of the double bottom to the upper turn of bilge, now not infrequent, affords an additional safeguard. But while accidents due to grounding often cause the loss of vessels and of their cargo, in remarkably few cases would loss of life seem to be involved.

COLLISION

This source of danger is probably the cause of the majority of fatalities incident to travel by water, and means for minimizing the effect of collision are being given careful consideration by the maritime world, as the result of the loss of the *Titanic*. Collisions occur in so many different ways that it is difficult to decide what precautions will be effective in every case. Until the collision of the *Titanic* with an iceberg it was generally considered that if a vessel would not founder with any two compartments open to the sea, that vessel would be extremely safe. The number of vessels of which so much can be truly stated is very small.

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The safety of cargo vessels does not need Governmental regulation, except only in so far as the safety of the crew is concerned, as all questions relative to the safety of the cargo will be settled by the shipowners and underwriters to suit the demands of trade. It is probably true that the precautions which should be taken for the safety of the crew do not need to be as great as for the safety of passengers, for reasons which are chiefly economic. The advantages of not handicapping trade are so great that the taking of risks by the people engaged in any trade is accepted. In all building operations there is a loss of life for every sum of money spent, and while this is to be regretted, there does not seem any remedy which will prevent accidents entirely, except a complete cessation of work—and that is no remedy. The precautions which should be taken must be such as will not handicap the business unduly—and what is considered proper to-day in the present state of the arts and of public opinion may hardly seem sufficient a few years hence. The advancement which has been made in ocean navigation in one century shows that many of the risks of the former days have vanished. The increase in the number of lives involved in any one accident is the real reason why, at the present time, additional precautions are considered necessary.

It is suggested, therefore, that the basis for further precautions in the structure of vessels should be the number of lives involved; and further, that greater precautions should be taken for the lives of passengers than for the lives of an equal number of the crew.

Protection of the propelling machinery, which prevents loss of control of the vessel, would seem to be of next importance to protection from foundering. Double bottoms under machinery spaces to afford protection in case of grounding, and on vessels carrying a large number of passengers wing compartments to afford protection in case of collision would seem in order.

Protection from foundering in case of collision would seem to be obtained in proportion, as a greater or less length of a vessel's side could be open to the sea without endangering the buoyancy or stability. Double bottoms would be of little use for this purpose. Watertight decks near the waterline in intact condition would seem of no great benefit, as the damage would as like as not extend both above and below this deck; and, in most cases, they would seriously interfere with handling cargo. A fore and aft bulkhead at the center line would help to preserve the buoyancy, but would probably destroy the stability. Wing bulkheads spaced far enough from the side to be safe from injury by collision would be prohibitive in handling ordinary cargoes, and could be adopted with advantage in special cases only. Subdivision by transverse bulkheads is, therefore, the logical precaution to take. It is structurally simple, and transverse bulkheads interfere very little, if at all, with the handling of any kind of cargo, provided they are considered in the design of the handling appliances. Even lumber vessels can be built with numerous transverse bulkheads.

If it is determined that a vessel carrying a certain number of passengers and crew shall be safe from foundering with a certain proportion of the length of the side open to the sea, and it is attempted to obtain this result by transverse subdivision, diagrams may be prepared which will give an idea of the conditions which will exist as calculated for a hurricane deck coastwise passenger vessel. The vessel considered is 370 feet long from stem to propeller post, 49 feet 6 inches beam and 35 feet deep to hurricane deck. The collision bulkhead is located at 6 percent of the length of the vessel abaft the stem and the forward bulkhead of the machinery space is 46 percent of the length abaft the stem. There are six transverse bulkheads in all. The vessel was assumed under two conditions of loading, one to give a draft of 18 feet 6 inches and the other to give a draft of 24 feet.

The conditions as to draft and initial stability were first determined with the fifth part of the length of the vessel abaft the collision bulkhead open to the sea, considering the void spaces in the hold as 50 percent. For each condition of loading the freeboard at the collision bulkhead must exceed 25 percent of the draft, and the after bulkhead of the flooded compartment must extend above the load line, more than 18 percent of the draft.

With the fifth part of the vessel's length forward of the machinery space open to the sea, the height of the forward bulkhead of the compartment must exceed 19 percent of the draft, and the height of the forward bulkhead of the machinery space must exceed 13 percent of the draft above the load line.

With two-fifths part of the length of the vessel abaft the collision bulkhead open to the sea, the freeboard at the collision bulkhead must exceed 65 percent of the draft, and the forward machinery bulkhead must extend not less than 30 percent of the draft above the load line.

Initial stability seems satisfactory in all the conditions considered, but it must be remembered that the void spaces in the vessel are assumed to constitute 50 percent of the total, and this assumption will not be correct for vessels when carrying a small amount of cargo, or where the cargo is of great density, such as steel, iron ore, etc.

On this vessel, therefore, under the assumed conditions, transverse bulkheads spaced as shown, and extending to the deck below the hurricane deck, would afford protection in case of collision opening any one compartment to the sea, with draft intact not exceeding about 23 feet. They would also afford protection in case any two compartments were open to the sea, with draft intact not exceeding about 18½ feet. To afford protection at greater drafts, the bulkheads, with spacing shown, must extend to the hurricane deck, and the limit of draft would seem to be about 24 feet in case of damage bilging two compartments.

If the bulkheads are spaced closer, dividing the forward hold, for instance, into three compartments instead of two, better protection will be afforded in cases of ordinary collision and of grounding; and three compartments could be flooded with the same degree of danger as is attended by the flooding of two, with the wider subdivision. Or, if it is considered that the damage will not be likely to affect but two compartments, of length about 50 feet each, a greater load draft could be allowed for bulkheads extending the same distance above the keel. The interference with cargo handling and stowing would be appreciable, but not prohibitive.

If more than two-fifths of the length of a vessel is required to be flooded with safety, it would seem that the transverse bulkheads would need to be supplemented, so as to divide the vessel into cells, and this would be commercial in special cases only, as mentioned above. In the case of the *Titanic*, about 30 percent of the length of the vessel abaft the collision bulkhead was damaged, or 36 percent in all.

FIRE

While accidents by fire are more frequent on vessels at dock than while under way, it would seem that further precautions could be taken to prevent the starting and spread of fires than are taken on the average vessel. Completely inclosing the freight spaces by steel, including steel covers for hatches and ventilators, would seem proper on vessels carrying any considerable number of passengers. The elimination of a large quantity of wood and other combustible material from passenger quarters can be made in many vessels at small first cost, and in some vessels at a saving in cost. The traveling public, which approves of steel railroad coaches, will probably offer no objection to greater simplicity on vessels if it is accompanied by an assurance of increased safety.

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City of Annapolis and City of Richmond

Description of Hull and Machinery of New Steamship Built by the Maryland Steel Company for Service Between Baltimore and Richmond

The *City of Annapolis* and *City of Richmond* are two new steamships recently completed by the Maryland Steel Company for the Chesapeake Steamship Company for service on the Baltimore and Richmond route.

That the management of the Chesapeake Steamship Company is alive to the interests of its patrons is being demonstrated by the service it affords. These new steamers are classed among the finest and most modern that run out of Baltimore; they combine all the comfort, convenience and luxury that the traveling public now demands, and the manner in which the Maryland Steel Company, under the direction of Mr. Key Compton, president of the Chesapeake Steamship Company, has fitted up these vessels speaks for the same popularity with the traveling public that the Baltimore & Norfolk Line has enjoyed since its earlier steamers, the *City of Baltimore* and *City of Norfolk*, were put in service.

The general dimensions are as follows:

Length over all	277 feet
Length between perpendiculars	267 feet
Beam, molded on waterline	43 feet
Beam, molded over guards	53 feet
Depth, molded to main deck	16 feet 5 inches
Draft, loaded	12 feet 6 inches

These vessels are built on the Isherwood system of longitudinal construction, and are classed by Lloyd's A-1 for twenty years for bay service.

HULL

The hull is constructed of mild open-hearth steel, with flat plate keel, bilge keels, lower and main decks. The main deck is plated all fore and aft, with a wood deck over. The stem, stern post and rudder are of the best hammered scrap iron. There are seven bulkheads, of which five are watertight.

The general finish is old ivory throughout the saloons, passengers' dining saloon, smoking room and lobby. The lobby on the main deck aft is finished in selected mahogany, as are all main stairways. Ornamental metal balustrades are fitted on all stairways and around the wells. The ladies' saloon aft, on the main deck is finished in sycamore. The president's room is on the gallery deck, and is paneled in old ivory. The captain's quarters consist of office, bedroom and private bath, and are finished in quartered oak. The other officers and the crew have quarters on the hurricane deck, aft of the captain's suite, and the finish throughout is cypress, finished natural. The officers' and crew's mess room, pantry, bathroom and showers are also on this deck. A private stairway leads from this deck to the main deck for the use of the crew and stewards. Over the well in the after saloon is fitted a large skylight with ornamental ceiling, and over the main stairway aft is a large dome skylight fitted with a sash of polychrome leaded glass. Opening off the smoking room on the gallery deck are the wireless room, a barber shop and a commodious bar. The chief engineer and assistant engineers have large rooms on the main deck aft of the freight space and alongside the smoking room.

There are four staterooms with two berths and showers; ninety staterooms having two metal berths; seven bedrooms with brass beds, five of which have showers; nine bedrooms with brass beds and private baths communicating; seven staterooms with two metal berths and private bath communicating, making a total of 117 staterooms. All staterooms are fitted with independent heat and running water. The outboard staterooms and bedrooms are fitted with inter-communicating telephones and the inside rooms with return call bells. Telephones are also fitted in the president's room, purser's office, bar, wireless room, dining rooms, captain's room, chief engineer's room and engine room. The spaces on the lower deck forward and aft are divided into quarters for first and second class men and women; aft on main deck is a ladies' cabin.

The pilot house is large and roomy, and is finished in oak, and has all necessary mechanical telegraphs and speaking tubes to the engine room, also McNab and running light indicators.

The floors of the dining saloon, lobby, smoking room, toilets and treads of all stairs are covered with interlocking rubber tiling. The saloons are carpeted, and all staterooms except those with showers are carpeted. The bedrooms with showers are fitted with hardwood floors and rugs.

The vessels are fitted with a steam windlass, steam steering engines and steam elevator engines. In addition to the steam steering gear there is an auxiliary hand gear located on the saloon deck aft.

Turbine-driven generators supply the current for lighting the vessels.

The baths and showers are fitted for both hot and cold fresh and salt water, the water being heated by a steam heater in the engine room.

MACHINERY

The main engine is of the four-cylinder, triple-expansion, surface-condensing type, having cylinders 23 inches, 38 inches and two 45 inches diameter by 36 inches stroke. The cylinders are arranged with one low-pressure at the forward end and one low-pressure at the after end of the engine. They are supported at the front by round wrought steel columns and at the back by cast iron "Y" columns. The back columns are fitted with crosshead guides of the hollow bar type. The connecting rods have brass boxes at the top and bottom with gib and key connections.

The crankshaft is of the built-up type in two pieces. The bedplate is of cast iron, having four short and two long main bearings. The bearings consist of two brass boxes held in place by wrought steel binders and steel bolts. The valve gear is of the Stephenson link type, with a steam ram reverse engine located at the back of the main engine. A one-cylinder steam turning engine is located on the after side of the after low-pressure back column, and operates through worm and gearing on the crankshaft. A main air pump, 22 inches diameter by 13 inches stroke, and two bilge pumps, each 5 inches diameter by 13 inches stroke, are driven by levers and links from the after low-pressure crosshead.

As these boats operate on a night schedule it is essential that the engine be as nearly balanced as possible. This was done by a system of equalizing the moving weights. In regular service it was found that the engines were remarkably quiet. The *City of Richmond* was also tried at the builders' dock with the wheel removed and the engine ran at its normal service revolutions per minute, at which speed there were no perceptible vibrations.

The propeller is of the built-up type, having a cast iron hub and four manganese bronze blades. It is 11 feet 6 inches diameter by 16 feet 3 inches pitch.

Steam is generated by four single-end Scotch type boilers each 12 feet 10 inches diameter by 10 feet 10 inches long, containing three, 41 inches inside diameter, corrugated furnaces. The boilers are built to meet the requirements of the United States Steamboat and Lloyd's inspection rules for 190 pounds

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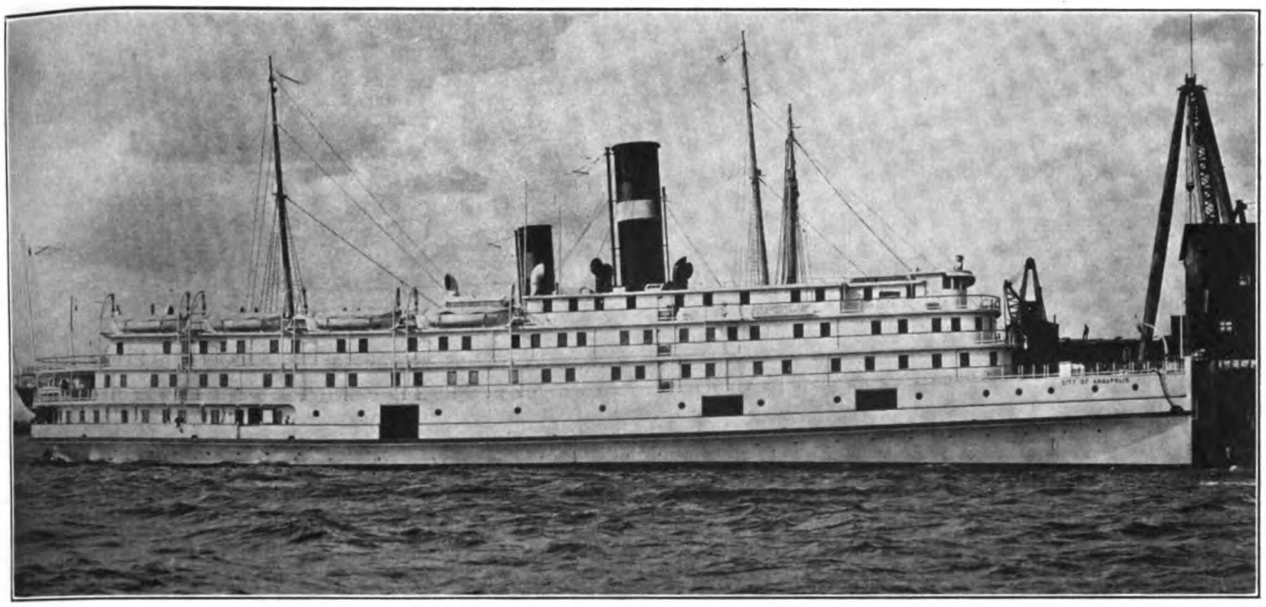

Fig. 1.—Bay Steamer City of Annapolis

working pressure, the total heating surface being 6,845 square feet and the total grate surface 225.5 square feet. A donkey boiler of the return tubular, dry-back type, 7 feet 3 inches diameter by 6 feet long, built for 190 pounds working pressure, is located on the main deck in a casing.

The main condenser is independent of the main engine framing, and is located at the back of the engine; it contains 3,810 square feet of cooling surface. The following auxiliaries are fitted:

A multi-coil feed water heater, two 25-kilowatt turbine-driven electric sets, one 5-kilowatt engine-driven electric set, two vertical simplex 10-inch, 6-inch, 24-inch feed pumps, one horizontal duplex 6-inch, 5¾-inch, 6-inch condenser drain pump, one vertical duplex 12-inch, 7-inch, 12-inch fire and donkey pump, one horizontal duplex 6-inch, 7½-inch, 6-inch sanitary pump, one horizontal duplex 5¼-inch, 4¾-inch, 5-inch fresh water pump, one centrifugal circulating pump with 12-inch nozzles, driven by a vertical single-cylinder 9-inch by 9-inch steam engine, one horizontal duplex 4½-inch, 3¾-inch, 4-inch mate's pump located forward, two horizontal duplex 3-inch, 2-inch, 3-inch hot water pumps and an ash ejector in the fire-room.

The character of the piping is first-class throughout, the main and auxiliary steam lines being of steel and all outboard piping of copper, not less than ¼ inch thick.

NATIONAL MOTOR BOAT SHOWS.—Two important motor boat shows will be held this year by the National Association of Engine and Boat Manufacturers. The first is the tenth annual National Motor Boat Show, which will be opened in Madison Square Garden, New York City, Jan. 31, closing Feb. 7. The second is the first annual Chicago National Motor Boat Show, which will be held at the Coliseum, Chicago, Ill., Feb. 28 to March 7. More boats of diversified types will be shown this year than ever before and special interest will be attracted by the exhibits of heavy oil engines, several of which of American build will be shown. These motor boat shows merit the hearty support of all engine and boat manufacturers.

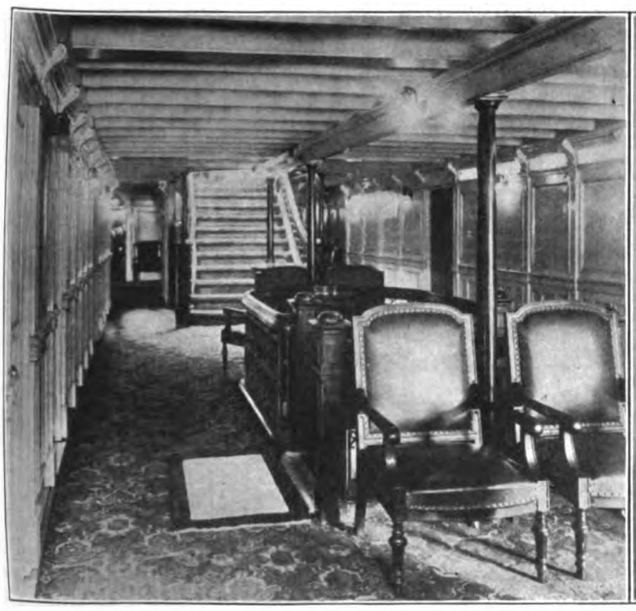

Fig. 2.—Social Hall

Fig. 3.—Stateroom

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American-Built Chinese Cruiser Fei Hung

Chinese Training Ship Constructed by the New York Shipbuilding Company—General Description of the Vessel and Trial Data

The *Fei Hung* is a light cruiser, built for the Chinese navy for use primarily as a training ship, although she is also available for all the war functions that can be expected from a vessel of this size and class. She is a deck-protected cruiser, driven by turbine machinery and carries an armament fully up to the standard of her class.

Constructed by the New York Shipbuilding Company, of Camden, N. J., from outline requirements supplied by the Chinese Government, she is of the same class as the *Ying Swei* and *Chao Ho*, recently completed in England. Some latitude was allowed the builders, so that all the boats have berth deck and in the poop. A large sick bay is fitted in the poop. The galleys are on deck amidships. The magazines are located on a platform deck, both forward and aft, with storerooms, etc., below in the holds, thus ensuring a maximum of protection.

The oil fuel is carried in tanks at each end of the machinery spaces. Trimming tanks, fresh water and reserve feed tanks are all provided.

Cold storage compartments are fitted on the protective deck abreast the engine hatch. Stowage for torpedoes is provided below deck. The weather decks are wood sheathed. Under

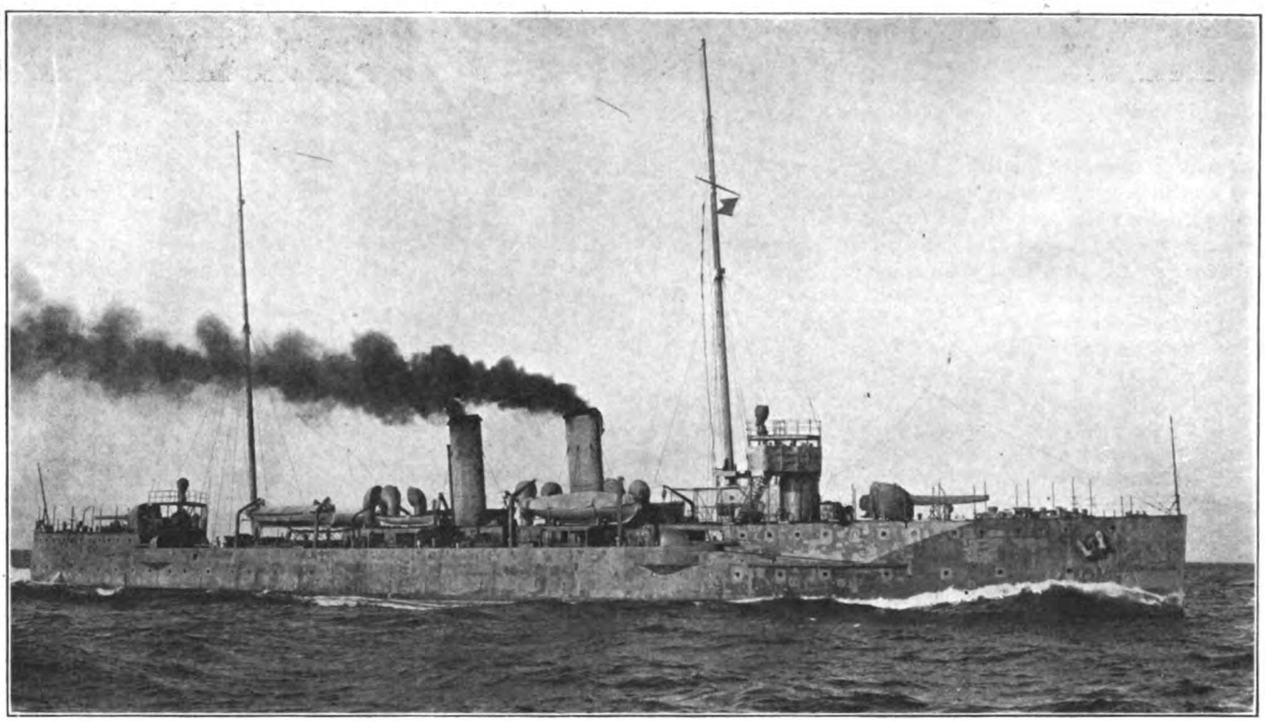

Fig. 1.—The Fei Hung on a Trial Run; Speed 20.536 Knots

minor differences in arrangement and motive power. What follows relates only to the *Fei Hung* unless specially noted.

The outline data and general description of the hull is as follows:

Length over all	322 feet
Length between perpendiculars	320 feet
Beam, molded	39 feet
Depth, molded	22 feet
Normal displacement	2,600 tons
Normal draft	14 feet
Freeboard, forward	18 feet 3 inches
Normal complement	230
Bunker capacity (coal)	600 tons
Bunker capacity (oil fuel)	100 tons
Full forecastle length	87 feet
Full poop length	58 feet
Double bottom, under machinery	117 feet

Fig. 1 shows the general appearance of the vessel; the officers are berthed in sixteen staterooms forward, in the forecastle and on deck; the crew are in large compartments on the

the bridge an armored conning tower and communication tube are fitted.

A very complete outfit of boats is provided, including one steam launch and one motor whaleboat; there are eight rafts and boats in all.

ARMAMENT

The vessel is armed as follows:

Two 6-inch guns, 50 calibres, with shields.
Four 4-inch guns, 50 calibres, with shields.
Two 3-inch guns.
Six 3-pounders.
Two 37-milimeter automatics.
Two 18-inch deck torpedo tubes.
Small arms for crew.

The 6-inch guns are located one on the forecastle and one on the poop; the 4-inch guns are on the main deck at the breaks of poop and forecastle; the 3-inch, 3-pounders and torpedo tubes are arranged along the waist, and the automatics on the forecastle deck under the bridge. All this armament, including the first supply of ammunition, was supplied by

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Sir W. G. Armstrong, Whitworth & Company, Ltd., in order that the armament of all the ships should be of similar make, using the same ammunition. The automatics are by Vickers, Ltd.

The gun trials were successful in every respect; several rounds per gun were fired with full charges, at varying degrees of train, followed by a broadside; this trial was carried out in connection with the speed trials. Armored hoists electrically operated, are fitted to each 6-inch gun, the other guns being served by hand whips. The torpedoes are stowed in boxes on deck and below in a special space.

Propelling Machinery

This vessel is fitted with an installation of Parsons turbines of the regular standard all-reaction type and design, which has proved so successful in vessels of this type. The machinery is arranged in one engine room, and there are three lines of shafting, with one propeller on each shaft.

The high-pressure ahead turbine drives the center shaft, and has fifty-six rows of blades in the casing and a similar number on the rotor, while the diameter of the rotor is 39 inches. At the forward end of this turbine a cruising element is arranged, which has an additional sixteen rows of blades in the casing and rotor respectively. This stage helps to improve the economy of the turbines at cruising speeds.

A combined low-pressure ahead and astern turbine drives each wing shaft, the low-pressure ahead turbines having sixty-four rows of blades in the casing and rotor respectively, with a drum diameter of 55 inches. Each astern turbine has forty rows of blades in the casing and rotor respectively, the drum diameter being 44 inches.

The turbine bearings are supplied with oil under pressure, while the line shaft bearings are lubricated on a ring system.

The turbine machinery worked most satisfactorily throughout all the trials, and the turbine bearing journals retained a constant temperature at all times. Heavy weather was experienced during the runs, with excessive rolling of the ship, but this did not appear to affect the steady running of the turbines in any way.

Dummy readings were taken regularly throughout the runs, and showed that the rotors were floating under nearly all running conditions, with consequently very light loads on the turbine adjusting blocks.

Auxiliary exhaust connections are arranged at different stages throughout the turbines, so that full use can be made of any available exhaust steam which the feed heater does not use and would otherwise be discharged directly into the condensers.

The boilers are of the Thornycroft express type, three in number, located in two boiler rooms, one in the forward room and two in the after room, all on the center line of the ship, flanked by the coal bunkers and with a cross bunker leading to each boiler for use in action. The total heating surface is 14,493 square feet and the grate surface 270.75 square feet. The working pressure is 240 pounds per square inch. The forward boiler is fitted with an auxiliary oil fuel plant, worked on the mechanical spray pressure system. The stokehold is closed and air forced in by means of blowers, one to each boiler.

The propellers are three in number, the wing screws turning outboard; the diameter is 66 inches and the pitch 62 inches; each having three blades.

The vessel is fitted with all the auxiliaries usually found in a cruiser of this type, such as mechanical ventilation, steam heating, cold storage plant, pumping, flooding and drainage systems; air compressors, electric lighting, steam steering gear, steam windlass and electric winches. Complete wireless, signaling and communication systems are installed.

The engines and the boilers were built by the New York Shipbuilding Company and the auxiliaries by standard manufacturers of the various types.

Trials

The results of the trials may be summarized as follows:

Item	Standardization, Mean of High Runs	Four-Hour Full Speed	24 Hours at 18 Knots
Displacement	2,600	2,600	2,600
Speed in knots	21.00	20.3	18.5
Revolutions per minute	560	535	478
Shaft horsepower	8,640	7,490	5,000

These trials were run in October last outside the Delaware Capes, the measured mile off the Breakwater being used for the standardization.

Annual Report of the Chief of the Bureau of Steam Engineering

Machinery of the Fleet

The upkeep of the machinery of the fleet is always a matter of first consideration, and in a fleet whose machinery aggregates nearly 2,000,000 horsepower it is to be expected that at one time or another some of the vessels will be out of service on account of defects or derangement of machinery, but it is gratifying to be able to report that the machinery of the fleet as a whole in excellent condition and that this applies to the vessels of both the active and the reserve fleets. The maintenance of the machinery of this fleet in such good condition is due in no small measure to the stimulus of engineering competition, to the practice of having regular overhaul periods for ships, and to the economical and efficient work done in the machinery division of the navy yards, without which it would not have been possible to keep the machinery of such a large fleet in good condition on an appropriation actually less than was available for a fleet of little more than one-half the power five years ago.

The turbine reduction-gear machinery of the *Neptune* has been continued in service while waiting for the completion of a new set which the contractors will install. The reduction gear has proven quite satisfactory.

The *Yorktown* has completed a general overhauling, including the installation of new boilers, and new boilers have been installed in several tugs and colliers. The usual retubing of boilers and condensers has been carried out, and considerable work has been done in the manufacture of propellers and propeller blades.

A number of alterations have been made tending to improve the machinery of vessels of the fleet, the most important being the installation of turbine driven blowers to replace old ones driven by wornout reciprocating engines, and improvements in the method of introducing boiler feed water.

The work of converting the *Vestal* into a repair ship is practically completed, and similar work on the *Prometheus* is well under way.

Design of Machinery

Plans and specifications were prepared for the machinery of the battleships *Pennsylvania* and No. 39, for torpedo destroyers Nos. 51 to 56, inclusive, for the destroyer tender *Melville*, and the submarine tender *Bushnell*, contracts for which have been awarded. Plans were also prepared for the machinery of the collier *Kanawha*, building at Mare Island.

Contract has been entered into for plans for the heavy oil engines of the *Maumee*, a sister ship of the *Kanawha*, and it is expected that the work of constructing these engines will soon begin at the New York Navy Yard. These engines will be built under the special authorization given in the last naval appropriation bill, and their construction and installation should contribute greatly to our knowledge of this type of engine and its possibilities for use for the large power required in battleships.

The design of a type of engine for colliers and vessels of

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that type has been undertaken, and the engines of the *Kanawha*, mentioned above, are based on this design.

The electrical propelling machinery of the *Jupiter*, at the date of this report, is ready for trial, and the results of the experience with it are expected to furnish valuable information regarding the adaptability of this type of machinery for naval vessels. Being the first installation of the kind on such a large scale, the trials will be watched with great interest by marine engineers in general, and it is hoped that the experiment may be of such a satisfactory character as to justify the further installation of this type of machinery.

The use of oil as fuel has continued, and all the latest designs of battleships, as well as destroyers, provide for the use of oil only. The admirable work carried out at the oil-fuel-testing plant, Philadelphia, has been productive of much valuable information on the subject of oil burning, and, supplemented by the experience in destroyers, has resulted in the development of an oil burner and air register which have given excellent results in service from an economic standpoint, and have effected a marked improvement in smoke reduction.

Some improvements have been made in the design of bureau type gasoline (petrol) engines which have contributed to efficiency of operation and have also resulted in reducing the cost of manufacture.

New Construction

Work on the machinery for the battleship *New York* has proceeded in a most satisfactory manner at the New York Navy Yard, and its installation is now in progress. The only other yard where the construction of machinery is now carried on is Mare Island. There the machinery of the river gunboats *Monocacy* and *Palos* is well advanced, and that of the collier *Kanawha* only recently begun.

Electrical Work

Thorough consideration has been given the subject of improving the lighting and wiring of ships, with the result that leaded and armored conductors have been adopted instead of plain conductors run in conduit, and that lighting fixtures have undergone complete redesign. In the consideration of this subject the bureau enlisted the co-operation of the foremost lighting engineers of the country, whose suggestions were given the fullest consideration, and it is believed that the progress which has already been made will result in greatly improving the lighting conditions on board ship.

The efforts that have been made to reduce the cost of searchlight mirrors by purchasing them in quantity sufficient to meet the demands of the fleet for a period of time have not only effected this purpose, but have also resulted in the production of mirrors in this country which it is confidently expected will be equal in efficiency to those formerly purchased abroad. This is a matter of no small military importance, but as it is accompanied by a marked reduction in cost, the commercial aspect of the case is none the less gratifying.

The number of searchlights on all battleships has been reduced from 16 to 8, and those which have been removed from ships having 16 searchlights will be used in bringing other battleships' and destroyers' searchlight equipment up to what is considered the standard. All of the older destroyers are to be modified by the installation of larger searchlights than they now carry.

Fuel Oil

The established policy of the department being that all battleships and destroyers shall use oil fuel exclusively, it is becoming a matter of the first importance to assure an adequate supply at a reasonable price. The price of oil is advancing so rapidly as to increase materially the navy's expenditure for fuel, and with the increasing demand for petroleum products further increase in the price of oil may be anticipated. To counteract this in small measure the navy might use oils not so well suited for its needs, but this would be at a sacrifice of efficiency, and some of the advantages that are to be secured with good oil would have to be sacrificed. The only method of insuring cheap oil embodying the refined products most adaptable to smokeless high-speed running appears to be to begin our own producing and refining, and in order to accomplish this it is strongly recommended that the department take the steps necessary to lease oil lands and to establish and operate a refinery. If this is done the sale of gasoline (petrol) and illuminating oils obtained from the crude oils, and which are not needed in fuel oils, will, it is believed, go far toward covering the expense of operation, and the navy will thus obtain a grade of oil in every respect suitable for its use, and at a cost far below the present price.

Tests of Subaqueous Coal

The coal stored at New London has been given an annual evaporative test during the two years it has been stored there, and no difference in evaporative efficiency has been shown between that stored under cover and that under water.

Launch of the Blavet

On Aug. 6 the Ateliers & Chantiers de Bretagne launched from the yard of the Pont Tournant the steamer *Blavet*, built to the order of the Société de Bois & Charbons F. Lebrise, Lorient. The vessel is especially designed for carrying coal between Lorient and the Bristol Channel. She is of the well-deck type, and has been built under the special survey of the French Veritas. The main particulars are:

Length over all	221 feet 6 inches
Length between perpendiculars	213 feet 3 inches
Breadth	34 feet 6 inches
Depth at main deck	14 feet 5 inches
Draft at full load	13 feet 2 inches
Displacement at full load draft	2,165 tons
Deadweight	1,200 tons
Gross tonnage	1,125 tons
Indicated horsepower	755

The hull is divided by transverse bulkheads into five watertight compartments. A double bottom with a capacity of 240 tons of water for ballast extends throughout the length of the ship. There is only one deck, and large hatches are provided. served by derricks of 1½ tons lifting power actuated by steam winches.

Steam is supplied to the main and auxiliary machinery by two cylindrical boilers, working under natural draft at a pressure of 185 pounds per square inch. The total grate area is 73.59 square feet and the heating surface 2,218 square feet.

The main engine is of the triple-expansion type, with cylinders 15, 25 and 40 inches diameter, with a common stroke of 26 inches. At a speed of 120 revolutions per minute the engine develops 775 indicated horsepower. The propeller, of the four-bladed type, is 10 feet in diameter.

A crew of fifteen, including the captain, is carried, and accommodations are provided for the owner. The officers' quarters are above the chart room, while the engine-room staff is berthed around the engine enclosure. The crew's quarters are forward in the forecastle.

The ways on which the vessel was launched had a total length of 246 feet and a declivity of 7.5 percent. Twenty cables, each having a breaking strength of 20 tons, were arranged to check the progress of the ship down the ways, but only sixteen were broken when the ship was brought to rest at a distance of 100 feet from the end of the ways.

Launch of Japanese Battle Cruiser.—The battle cruiser *Haruna*, of 27,500 tons displacement and 28 knots speed, was launched at Kobe, Japan, Dec. 5

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Notes on the Performance of the S. S. Tyler

A Plea for Adequate Trial Trips of Merchant Vessels—Trial Data from an Interesting Cargo Steamship Built for the Old Dominion Line

BY E. H. RIGG

The comparative scarcity of accurate and full accounts of the performances of ships built in the various yards has frequently been deplored in connection with papers read before this and kindred societies. This point came up in connection with the short paper read here by myself last year, and it is more to follow up one point then brought forward that the present paper has been prepared rather than on account of any extraordinary interest or originality attaching to the following remarks and figures.

It is comparatively an infrequent occurrence for trial data of merchant ships to be allowed publicity, and the thanks of the author are due to the Old Dominion Steamship Company, the owners, and to the New York Shipbuilding Company, the builders, not only for permission to record here the results achieved, but also for co-operation in furnishing the information necessary for comparative purposes.

In a paper entitled "Notes on Fuel Economy as Influenced by Ship Design," read before this society at the general meetings last year, reference was made to the vessel which forms the subject of the present paper. Certain hopes were indulged in as to her performance as a coal saver, compared with similar vessels; since that time she has been completed for sea, run her trials, and been in service long enough for results to be available, and it is hoped that these will not be without interest to members of the society.

Reference to page 233 and Plate 95 of our 1912 Transactions will give details of the lines and of the model experiments carried out during the design stage of this vessel. Later it was decided to build the vessel 331 feet long between perpendiculars; whereas a model representing a 308-foot 6-inch ship had been towed. This change introduces a necessity for careful calculation to get the effective horsepower for the longer ship. The curve of effective horsepower herewith has been deduced as follows:

Both ships were worked up from Taylor's standard series. A percentage difference between the model as towed and the shorter ship calculations was obtained and applied to the longer ship calculations to get the required curve, which, therefore, represents the ship as built.

In laying down the *Tyler*, middle body was added to obtain the new length; the bilge lines were eased, so that there is, strictly speaking, no parallel middle body. On the floor and sides, however, there is some fifty feet of parallel body, or 15 percent, which is the figure for minimum residuary resistance, the easing of the bilge being so slight that the vessel has this amount of parallel body for all intents and purposes.

In the 1912 paper a claim was made for a 3 percent saving, due to the forward lines; the trials at the Delaware Breakwater amply justify this claim; recent average practice would require at least 2,000 indicated horsepower for 12¾ knots; 1,750 indicated horsepower, as realized, therefore represents a 12½ percent saving, all of which, however, is not claimed for the bow lines; it would not be difficult to cite similar cases requiring 2,100 indicated horsepower for this speed.

It is to be regretted that there is no other ship in the Old Dominion fleet that can be compared directly with the *Tyler*. The *Madison* is a larger vessel, passenger carrying, and four knots faster. These ships compare approximately as follows:

	Madison	*Tyler*
Length	359 feet 0 inches	331 feet 0 inches
Breadth	42 feet 0 inches	47 feet 0 inches
Draft	16 feet 6 inches	16 feet 6 inches
Displacement	4,500	4,750
Sea speed (knots)	16	12
Indicated horsepower.	4,000	1,750

Both vessels have a single screw. These figures are included more to show the difficulty of comparison than as an actual comparison. From effective horsepower curves from a previous vessel it is, however, possible to arrive at a fair comparison. The type vessel is similar to the S. S. *Madison* in general form.

Item	*Type*	*Tyler*
Length	350 feet 0 inches	331 feet 0 inches
Breadth	42 feet 0 inches	47 feet 0 inches
Draft	17 feet 10 inches	16 feet 11 inches
Displacement	4,875	4,875
Block coefficient	.65	.65
Speed in knots	13	13
Effective horsepower	1,100	1,200
Ratio, beam to draft	2.36	2.78
Speed length ratio	.695	.715

The *Tyler* is shorter and wider than the type ship and only requires 100 more horsepower for the same speed at the same displacement. Both these performances are creditable to the designers, but especially so in the case of the shorter and wider vessel. The *Tyler* is an example of a case where several cooks did not spoil the broth.

Besides the Old Dominion Steamship Company and the builders of the vessel, Naval Constructor D. W. Taylor and the Newport News Shipbuilding Company had a hand in preparing the lines of the vessel.

Turning to the propeller side of the question, the propulsive efficiency at 12¾ knots is seen to be some 63 percent, which, I think, will be admitted, is a good performance.

In warship trials an accurate curve of effective horsepower is generally available, but only very rarely for merchant ships; this fact renders the *Tyler's* trials decidedly more interesting.

The propeller data will be found in Table 1; the builders were responsible for its design.

The mean depth of water on the course was some 165 feet; information from shoal water trials shows that this is an ample depth for the draft and the speeds attained; the results are therefore not complicated by shoal water effects. The mean depth on the approaches was about 110 feet and this figure also is reasonably satisfactory. The approaches refer to a length of one mile each side of the range buoys. Minimum suitable depth for this vessel is about 125 feet. The service in which these vessels are engaged is a coastwise one, between New York City and Norfolk, Va.

Since the vessel has been in service she has made frequent trips at a mean draft of 17 feet, and has made a speed of slightly over 12 knots between the lightships. I hope Mr. Higgins will be able to supplement these figures with later data on her sea performances.

TABLE NO. 1

Hull and Machinery Data

Length over all	344 feet 0 inches
Length between perpendiculars, W. L.	331 feet 0 inches

*A paper read before the Society of Naval Architects and Marine Engineers, New York, December, 1913.

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Beam, molded	47 feet 0 inches
Depth, molded	35 feet 0 inches
Draft, aft, on trial	17 feet 11 inches
Draft, forward, on trial	15 feet 11 inches
Draft, mean, on trial	16 feet 11 inches
Trim by stern	24 inches
Corrected displacement (long tons)	4,875
Freight earning deadweight (long tons)	2,350
Block coefficient	.650
Longitudinal coefficient	.682
Wetted surface (square feet)	20,000
Engine, triple expansion.	
Cylinders	19¾ inches, 33¼ inches, 58 inches
Stroke	42 inches
Boilers, S. E. Scotch (number)	2
Heating surface, total (square feet)	4,182
Grate surface, total (square feet)	105
Draft, heated forced .	
Working pressure (pounds)	200
Dimensions, 13 feet 8 inches diameter, 12 feet 0 inches long	
Propeller, four-bladed, solid, cast steel.	
Diameter	14 feet 6 inches
Pitch	14 feet 6 inches
Projected area (square feet)	66.7
Developed area (square feet)	80.0
Gross tonnage	3,928
Net tonnage	2,960

TABLE NO. 2

Results on Standardization Trials. Delaware Breakwater Course, Aug. 3, 1913.

(Weather, clear and warm; calm sea; light westerly breeze; ranges clearly visible.)

Run and Direction.	Elapsed Min.	Time Sec.	Revolutions Per Minute.	Indicated Horse-power.	Knots.	Slip Percent.
1—N	7	10.2	59.15	438	8.368	1.108
2—S	8	12.5	57.53	424	7.310	11.270
Mean			58.34	431	7.839	6.189
3—N	5	33.2	74.35	746	10.804	—1.55
4—S	6	42.3	75.30	850	8.948	16.95
Mean			74.82	798	9.876	7.70
5—N	4	39.8	83.00	1128	12.866	—8.31
6—S	6	14.0	82.95	1118	9.626	18.87
Mean			82.97	1123	11.246	5.28
7—S	4	49.5	92.90	1605	12.435	6.45
8—N	4	59.2	92.80	1602	12.032	9.43
Mean			92.85	1604	12.233	7.94
9—S	4	26.2	95.95	1788	13.524	1.509
10—N	5	17.2	94.75	1682	11.349	16.360
11—S	4	05.2	95.65	1723	14.682	—7.29
12—N	5	35.4	95.90	1806	10.733	21.85
True Mean			95.38	1750	12.793	6.345

NOTES ON STANDARDIZATION

1. After run No. 6, the vessel hauled off to await the change of the tide from flood to ebb; 2¾ hours elapsed between end of No. 6 and beginning of No. 7.

2. Runs Nos. 7 and 8 were thrown out in plotting the speed and power curves; it was noticed that the tide had not set down and was still running oblique to the course. It is to be noted that the revolutions and power spots check well, but the speed is evidently not correct; the slip curve also bears this out.

3. Four high-speed runs were made and a mean of means taken; this establishes the top spot beyond question.

4. On run No. 9 the *Tyler* and the *Narragansett* passed on the course, one to the west and the other to the east of the buoys; it is probable that each affected the other slightly.

5. On run No. 10 it is to be noted that the steam pressure dropped back and consequently the indicated horsepower fell about 100 below the average for the other three high runs. Full pressure would have made the top speed 12.875 knots.

TABLE NO. 3

Propulsive Efficiency

From the above data the efficiency figures are as follows, taking the ratio between total effective and indicated horsepowers:

R. P. M.	Speed in Knots.	E. H. P.	I. H. P.	Efficiency in Percent.
60	8	270	460	58.7
67	9	380	625	60.8
74	10	520	820	63.4
81½	11	685	1060	64.6
89	12	875	1385	63.2
97½	13	1190	1870	63.6

Displacement, draft, etc., will be found in Table No. 1.

It will be noted that at top speed the propeller shows no signs of breaking down.

Electric Propulsion on S. S. Jupiter*

BY W. L. R. EMMET

When the first tests of the *Jupiter* operation were made she had been lying at the Navy Yard dock for four months, so that her bottom was in a very foul condition. Her speed in that condition was something like 25 percent below normal. This produced abnormal electrical conditions, since the low frequency made necessary the use of higher magnetic densities than are desirable. Many of the conditions of these runs were very unfavorable. A large proportion of the crew were green men; in one fireroom watch a large proportion of the fireroom force were seasick. A great deal of boiler compound was used in the boilers, and the priming was excessive. The condensed water was much discolored by boiler compound, and water was at frequent intervals forced from the valve packings.

The operation of the apparatus during these runs was exactly in accordance with expectations. The turbine ran with a very perfect balance, and ran just as steadily in rough water as in smooth. The governor held its speed perfectly. The lifting of the propeller to the surface at no time caused any perceptible speed variation. The only effect of such lifting of propellers was a fall of current on the instruments showing a diminution of power delivered to the propellers. Examination of the turbine after several such runs had been made showed it to be in perfect condition and free from rust, scale or dirt.

After this period of preliminary trials the ship was docked and since that time she has made a set of standardization runs and a 48-hour unofficial trial with a clean bottom. On this 48-hour trial the ship averaged 14.78 knots, the average power delivered by the generator was 5,000 kilowatts, corresponding to about 6,300 horsepower. The average revolutions of the propeller were 115. The *Cyclops* in her official 48-hour run made 14.61 knots, with an average of 6,705 indicated horsepower.

The power required by the *Jupiter* in this 48-hour run is somewhat less than would be expected from the *Cyclop's* performances, and the slip of the propellers is also less than was expected. It has been suggested that this difference might,

*From a paper read before the Society of Naval Architects and Marine Engineers, New York, December, 1913. For a description of the *Jupiter* and her machinery see INTERNATIONAL MARINE ENGINEERING, August, 1913, page 323.

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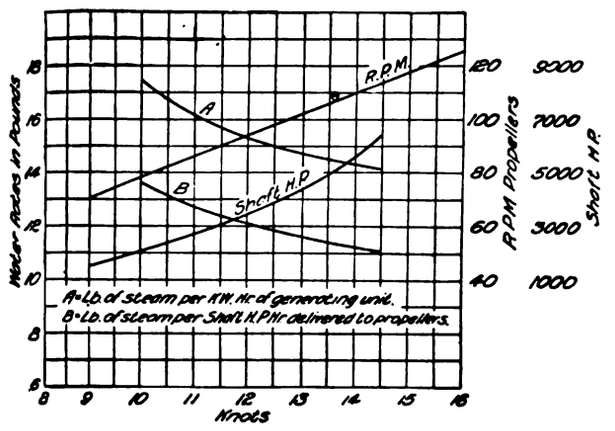
in some degree, be attributable to the fact that in the *Jupiter* the torque delivered to the propellers is continuous, while with the reciprocating engines the impulses are intermittent. Careful investigation would be necessary to ascertain whether there could be anything in such a theory. It has also been suggested that there would be some advantage in the fact that the *Jupiter's* propellers were entirely free from racing, but since some of these tests were made in quite smooth water this could hardly have had any effect. If no advantage is gained through these causes it would certainly seem that the



Water Rates U. S. S. *Jupiter*—Conditions 190 Pounds Gage, 28.5 Inches Vacuum, No Superheat

performance of the *Jupiter's* propellers is very creditable to Captain Dyson, who designed them.

Through a misunderstanding the steam pipe on board the *Jupiter* was made much too small, so that the normal pressure at the turbine cannot be attained. The vessel will not give her best performances until this is corrected, and until an effective separator is put between the boiler and the turbine so that the efficiency of the turbine will not be affected by priming. It is believed that when these changes are made the *Jupiter* can, if desired, be operated at a much higher speed than that which has been attained, and that her economy will prove to be far better than that of any vessel afloat.

The steam consumption of the *Jupiter* turbine and the efficiency of all her apparatus have been determined by exhaustive tests at Schenectady, and is also accurately known through knowledge of the performances of other similar apparatus. These results are shown by the accompanying curve, and they cannot fail to be accomplished in the ship herself when all conditions are normal.

Since the preliminary trials above mentioned, the *Jupiter* turbine has been injured through the breaking of a half-inch top bolt, which held the section of stationary buckets used in the first stage of this machine. On account of this trouble her official trial has been postponed, and it is hoped that the steam pipe will be changed and a separator put in before the official trial is made. A section of stationary buckets held by these bolts is the only detachable part in this turbine. Tap bolts are subject to the danger of breaking under such conditions, and we have had trouble with such method of attachment in other turbines. The matter in this case was, however, unfortunately overlooked. The trouble is easily corrected, and the accident has no significant bearing upon the demonstration which this ship has made. While this bolt destroyed all the buckets in the first stage, the turbine was still capable of operation. The turbine was taken apart because it was seen that the economy was not normal. By taking out the bolt which was adrift and clearing the damaged parts which might interfere, the ship could still have been operated indefinitely at normal speed with a very fair economy. Such arrangements could be made in a few hours.

Four years ago I presented my first paper on Electric Ship Propulsion to this society. A year before that I had designed an equipment for the battleship *Wyoming*, and a proposal had been made to the Government in which my designs were embodied. Since that time I have submitted several designs to the Government relating to equipments of battleships which have been built. My last design applied to a case like that of the *Pennsylvania* and was submitted last spring. My estimates as to the result of this equipment as compared with those which will be accomplished by the equipment which is being put into the battleship *Pennsylvania* are shown by the following table:

	Turbine drive with geared cruising turbines as adopted.	*Turbo-electric drive.*
Revolutions per minute, 21 knots.....	222	160
Horsepower required, 21 knots.....	31,700	29,200
Pounds of steam per hour turbines alone, 21 knots.....	374,000	305,000
Pounds of steam per hour turbines alone, 15 knots.....	106,000	91,000
Weight of driving machinery in tons..	749	598

With reasonable allowances for steam required outside of the main turbines it would appear that this ship, which is provided with 12 boilers, could, with the turbo-electric equipment, operate equally well with 10 boilers. If two boilers were omitted the whole weight saving would be 266 tons.

The Upkeep and Management of Boilers on a Tramp Steamer

At a meeting of Institute of Marine Engineers on Dec. 1 a paper on "The Upkeep and Management of Boilers on a Tramp Steamer," by Mr. G. A. O'Neill, was read. In dealing with the question of internal corrosion the author stated that sufficient care was not always taken, when fitting zinc plates in the boiler, to clean away the dirt and scale from around the necks of the stays so as to form a metallic contact. Soda was often used without any consideration as to the amount required. This could easily be ascertained by the use of litmus paper. The pitting frequently found along, and a little above, the line of the firebars on the water side of a furnace, could be arrested by making it a practice to clean thoroughly and remove the black scale, afterwards coating with a mixture of metallic zinc powder and clean fresh water. He did not agree with the practice of scaling furnaces only to the line of the firebars, and leaving the bottoms untouched. In modern ships a great many of the difficulties were eliminated by the use of independent feed pumps and efficient feed heaters.

It was quite a common rule in raising steam to light the fire in the center low furnace of a three-furnace boiler four or five hours before the others, but with the modern appliances for artificial circulation this practice was entirely unnecessary. It was also harmful by setting up undue strains on the front end plate. The bottoms of the combustion chamber on the fire side were liable to corrosion if not carefuly watched. Salt from leaky tubes and joints, when mixed with wet ashes, set up corrosion, and it was essential that any leaks noticeable should be stopped at the first opportunity. Corrosion at the bottom front end plates could be eliminated to some extent when at sea, if the ashes were removed from the furnace fronts immediately after the fires were cleaned, and not allowed to remain there until the end of the watch, as was often the case.

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Naval Architects' Annual Meeting

Abstracts of Interesting Papers Read and Discussed at Well-Attended Meeting of Naval Architects and Marine Engineers, in New York

The twenty-first annual meeting of the Society of Naval Architects and Marine Engineers was held in the Engineering Societies building, New York, Dec. 11 and 12. Morning and afternoon sessions were held each day and the meeting closed with a banquet at the Waldorf Astoria Hotel Friday evening, Dec. 12. On account of the illness of Col. Robert M. Thompson, president of the society, the meeting was presided over by W. M. McFarland, vice-president. According to the annual report of the secretary-treasurer, the membership of the society now stands at 770 as against 731 last year, and the total resources amount to $23,446.05 (£4,800) as against $18,000 (£3,700) last year. Through death the society has lost the following members:

Sir William White, honorary member; Charles H. Cramp, George W. Quintard, life members; Edwin S. Alexander, Thomas F. Carter, Edwin S. Cramp, William H. Fletcher, Robert Forsyth, Frank D. Hall, Valdemar F. Lassoe, members.

The following papers were read and discussed:

Relative Resistances of Some Models with Block Coefficient Constant and Other Coefficients Varied

BY NAVAL CONSTRUCTOR D. W. TAYLOR, U. S. N.

This paper is published on page 7.

Resistance of Bilge Keels

BY PROF. C. H. PEABODY

ABSTRACT

The experimental boat *Fulton* was used during the past summer to investigate the resistance of bilge keels, for which purpose it was well adapted both by the precision of results possible and because the stream lines are known.

The normal bilge keels were made 15 feet long and 3 inches deep; bilge keels 6 and 9 inches deep were also tested. Tests were made in addition on keels 3 inches deep and 19 feet long.

The apparatus on the *Fulton* is that described on page 87, volume 19 of the Transactions. The primary observations taken were: (1) Time on the course; (2) thrust of the propeller; (3) revolutions of the propeller, and (4) input to the electric motor.

The assembling of results was conveniently made by plotting all observations with revolutions for abscissæ. Sample curves are given of (1) speeds in knots per hour; (2) thrust of the propeller shaft in pounds, and (3) input to the electric motor in kilowatts. The first curves show a slight current at times, due probably to a wind acting before the tests; this current was in all cases less than a tenth of a knot per hour; it necessitated runs both with and against the current, from which the mean speed was definitely determined. The thrust was found to be practically the same for a given number of revolutions in all cases, with bare hull and with the several keels; consequently the thrust curve was well located. The determination of power (input to motor) was quite satisfactory; tests made at an interval of two weeks gave identical results.

In order to obtain results as indicated it was found necessary to run only when weather conditions were ideal; though such conditions might come at any time, day or night; the conditions were most frequently found at 4 o'clock in the morning.

The results of the experiments are reported in two forms:

(1) The ratio of the increment in propeller thrust, due to the addition of a given pair of bilge keels, to the computed frictional resistance of the keels.

(2) The ratio of the increment in power on account of the addition of a pair of bilge keels, to the computed power to overcome the friction of the keels.

For speed less than that corresponding to a speed length ratio 0.7 the increment in thrust corresponded well with the computed resistance of the keels; at higher speeds the resistance was greater than that due to friction up to a ratio of 1.5. The increment in power, due to addition of bilge keels, was notably larger than the power computed from the friction of the keels, the ratio varying from 2.5 to 3.5, the larger ratio being found at the higher speeds. The discrepancy between results from thrust and from power cannot be charged to error or uncertainty of observations or to methods of reduction, but is a real difference.

On the Possibility of Building a Large Passenger Liner That Would Not Under Any of the Known Mishaps at Sea Lose Her Buoyancy or Stability and Sink

BY GEORGE W. DICKIE

ABSTRACT

This paper seeks to point out a possible solution of the above problem as applied to a certain type of vessel, viz., the large, modern, passenger liner. New and ever-increasing laws concerning life-saving appliances have created a grave problem for the naval architect, both as to carrying heavy top weights and littering a large area of deck space with lifeboats and rafts. In brief, the suggestions embodied are the fitting of a double upper deck, and so arranging the watertight subdivision below the lower member of this deck that the ship would prove both seaworthy and unsinkable under the most aggravated conditions of flooding. The advantages to be considered in this arrangement as opposed to the drawback of wasted space are as follow: The space between the two members of the upper deck would be utilized for cold-storage rooms, air ducts, water and steam piping, stores, etc. The fire mains would at all times be under direct control. All horizontal piping and ducts through living spaces would be done away with. Communication to and from engine room, fire rooms, dynamo room and ventilating and refrigerating rooms would be through a continuous watertight passage fitted with automatic watertight doors which would operate from the influx of the sea. In a ship so constructed, and practicably, at least, unsinkable, would it be necessary to carry the great number of lifeboats now deemed necessary, and which, with the great freeboards of our ocean liners, are utterly useless except in the event of moderate sea and the speedy arrival of assistance?

Structure of Vessels as Affected by Demand for Increased Safety

BY WILLIAM GATEWOOD

This paper is published on page 21.

Stability of Lifeboats

BY H. A. EVERETT

ABSTRACT

This paper presents the results of inclining experiments and subsequent stability calculations upon four types of 28-foot lifeboats: First, standard metallic; second, standard wooden; third, decked metallic, and, fourth, collapsible wooden.

Two conditions for these were taken—light, and loaded to their rated capacity. In the loaded condition the first three types showed good stability with a range of about 30 degrees

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before the vanishing point was reached, and with the decked type giving the greatest curve of dynamical stability.

The curves are normal and quite what one would expect, though it is of interest to note the very appreciable increase in stability which is caused by the seating of about one-third the passengers on the bottom of the boat instead of on the thwarts and seats provided for them. It is noticeable, also, that the wooden boat has less stability than the metallic, though of the same external form. This was caused partly by the center of gravity of the boat itself being somewhat higher and partly by the fact that the thwarts and seats were about 1 inch higher above the keel than in the metallic boat. The construction plans show no reason why the thwarts and seats should not be lowered appreciably, and it would seem desirable to have them as low as possible.

For example, the wooden boat from the cross curves has an uncorrected righting arm, when loaded with fifty people and inclined at 30 degrees, of 0.90 foot. The distance of the center of gravity above the assumed axis of inclination is 11 inches, or 0.92 foot. The correction for the righting arm is then 0.92 × sin 30 degrees = 0.46 foot, and the corrected righting arm is 0.90 — 0.46 = 0.44 foot. Now, if the thwarts were lowered 6 inches the resultant center of gravity would be lowered 0.35 foot, in which case the correction would be 0.57 × sin 30 degrees = 0.28 foot, and the corrected righting arm would be 0.90 — 0.28 = 0.62 foot, which is an increase in statical stability of about 40 percent.

The curves of dynamical stability of Plate 9 give the most comprehensive comparison of the merits of the different types from the stability viewpoint. The collapsible boat sank with less than the allowed load on board, and had practically no stability with less than one-third the allowed load, as the angle of zero stability was 3 degrees.

The failure of this boat was undoubtedly due to water leaking into the chamber between the decks. The essentially vicious feature, from a construction point of view, is that in any wooden boat subject to the ordinary weather and wear encountered in normal service, leakage is bound to occur, and this leakage coming into a space from which no provision is made for bailing, insidiously diminishes the craft's stability and seriously impairs its buoyancy. The bulwarks are not intended to be watertight, and the stability curve when light has all the characteristics of that of the raft with its quick-rising curve of righting moments for very small angles, reaching zero stability at an angle vastly less than the standard type of boat.

A Substitute for the Admiralty Formula

BY E. A. STEVENS, JR.

ABSTRACT

This formula was derived from the Admiralty formula as follows:

$$I.H.P. = \frac{D^{2/3} \times V^3}{C}, \text{ or } V = \sqrt[3]{\frac{I.H.P. \times C}{D^{2/3}}}$$

Now

$$D^{2/3} = \frac{D^{5/6}}{D^{1/6}} = \frac{D^{5/6}}{\sqrt{D^{1/3}}}$$

As the length of vessels of similar models varies as $D^{1/3}$, L (or length $L\ W\ L$) was substituted for this factor, which gives

$$D^{2/3} = \frac{D^{5/6}}{\sqrt{L}}$$

Now, substituting this value of $D^{2/3}$, and taking C out of the radical, we get

$$V = C \sqrt[3]{\frac{I.H.P. \times \sqrt{L}}{D^{5/6}}}$$

In order to simplify the formula, $D^{5/6}$ was replaced by D.

Tables Nos. 2, 3, 4 and 5 show the values of C as worked out for several types of vessels.

Tables Nos. 9 and 10 and Plates Nos. 3 and 4 give, the writer believes, a very fair comparison of the relative accuracy of the new formula and the Admiralty formula.

By simple solutions of the formula for values of its various terms it appears that for ships of

(1) Same length and displacement, power varies as V^3.

(2) Same length and speed, power varies as D.

(3) Same speed and displacement, power varies as $\frac{I}{\sqrt{L}}$.

In presenting the formula, the writer does not claim that it is an accurate means for estimating the speed of ships, but merely one that can be used for preliminary calculations in place of the Admiralty formula with more accuracy. It is also easy to handle and requires less judgment and experience in its application.

The Evolution of the Lightship

BY GEORGE CROUSE COOK

ABSTRACT

The text of this monograph consists of a brief statement of the functions of the lightship as an aid to navigation, an outline of its origin and development, and a description of the first-class lightship, designated Lightvessel No. 94, of the United States Lighthouse Service. The illustrations consist of a sketch of the first-known lightship and the plans of Lightvessel No. 94.

Especial attention is invited to the following paragraphs:

In 1856, a paper, "The Form of Stationary Floating Bodies," was read at the Institution of Civil Engineers, London, proposing a circular vessel for a lightship. The discussion which followed developed a wide diversity of opinion as to what form was the most desirable. * * * Scott Russell, the distinguished naval architect of his day, spoke at some length, and said that he "would be inclined to give a lightship great length, with a safe but small section, and extremely fine lines."

Again in 1860, the question of lightship design received serious consideration in England. A "Royal Commission on Lighthouses" was appointed to inquire into matters pertaining to the lighthouse service. In the course of its investigations it sent out a series of questions to the distinguished "scientific men" of the day, including Rankine, Faraday, Herschel, etc. One of these questions referring to the lightship called for "opinions on the best form for the hull." The replies were most varied. * * * Some advocated longer vessels, others shorter; some recommended much sheer, others less; some favored bluff bows, others sharp, etc.; while several advised circular hulls moored at the center of gravity. Among the advocates of the last was Professor Rankine, of the Glasgow University.

A second question, "At what part of the vessel should the moorings enter?" elicited a variety of opinions; and hawse holes at a considerable height above the water, close to the water, and also under the water were proposed.

The practice of the United States Lighthouse Service in these features of design is indicated by the line draft, the curves of form, and the stability diagrams of Lightvessel No. 94, shown on Plates 3, 4 and 12.

The author repeats, again, the questions raised in 1860: What is the "best form for the hull"? and "At what part of the vessel should the moorings enter?" and invites discussion thereon by the members of the society.

Construction and Operation of Western River Steamers

BY RICHARD CLARKE WILSON

ABSTRACT

This paper is not considered a technical effort, but is presented merely as a criticism, or rather an explanation, of the

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medieval mode of handling and also building the present type of boats on Western rivers, and it is endeavored to show a mechanical solution of the cause of the gradual diminution of the river traffic.

The designs were so completely covered in the paper by Mr. Charles Ward, read before the Detroit Summer Meeting, that it is believed to be useless to go into any sort of details of construction. The same types and construction prevail, and will for years, as the older captains and others concerned in the operation and maintenance are bound to hold tightly to what they have, and what their fathers and grandfathers had before them.

The Influence of National Policies on Ships' Design

BY CAPTAIN W. L. RODGERS, U. S. N.

ABSTRACT

1. This influence has been marked at all periods of history.
2. Historical examples:

Actium, 31 B. C. Spanish Armada, 1571 A. D. American Civil War	show that policy rules types of ships.

3. Lack of control of ship design by national policy in United States during period from Civil War to Spanish War led to unsuitable types.
4. Present arrangements in Navy Department to ensure that general military characteristics of ships shall be such as best to support national policies.
5. Example taken from history of German ship building shows that foreign powers build their navies with definite foreign policies in view.
6. Conclusion that naval architests must keep in close touch with the exponents of national policy.

Strains in Hull of Ship at Sea and those Measured While Receiving Cargo

BY JAMES E. HOWARD

ABSTRACT

The paper presents the results of measurements made on the plates of the shelter deck of the steamship *Ancon*, of the Panama Railroad Steamship Company, on the voyage from New York to Colon and return, also observations on the deck plates during the time the ship was taking cargo aboard at New York.

Live load strains on the deck plating while at sea were made with a new type of live load extensometer, a scissors gage, so called from the resemblance of its working parts to a pair of scissors. This instrument has an ultimate sensitiveness of one-hundred thousandth of an inch. The strains in the deck, observed during the time of taking aboard cargo, were measured with a strain gage of telescopic tube type with micrometer screw attachment, having a sensitiveness of one ten-thousandth of an inch.

The observations made at sea embraced those taken on the shelter deck, forward and aft of the superstructure, showing the longitudinal changes on gaged lengths of 6 inches each, which took place due to the pitching of the boat and vibrations which were due to the rotations of the engines. These measurements were made both on the solid plates and spanning the lap joints of those plates.

On the outward trip the ship carried a full cargo of about 10,000 tons. It was found with this load, and during good weather with a smooth sea, that the rotations of the engines caused the development of greater strains in the deck than those which were due to a moderate pitching of the boat.

The measured strains reached a maximum in the vicinity of the after bulkhead of the superstructure, where they corresponded to a stress of 2,250 pounds per square inch, on Course B of the plating. The strains over lap joints in this vicinity were twice those observed on the solid metal of the plates. These longitudinal strains were less on plates farther aft and ceased to be measurable before reaching the stern.

On the forward part of the ship the strains in the solid plates, Course C, ranged from 100 to 650 pounds per square inch, according to position, but disappearing as the bow was approached. Greater rigidity prevailed in the stringer course of plating and across the butt joints of that course, both forward and aft, than in the lap-jointed plates.

A few observations were made prior to the main series, when a moderate sea was running, which showed stresses in after part of the deck near the bulkhead ranging from 2,500 to 3,500 pounds per square inch. The greatest stress found during these observations was on the angle of the bulwark rail, immediately aft the superstructure, where a range of 5,500 pounds per square inch was observed.

While the live load strains on the outward trip were greater, due to the rotations of the engines than those caused by the pitching of the boat, the reverse was the case during the return trip from Colon to New York. Northbound, the boat carried only about 3,000 tons cargo. The pitching strains then were generally double those due to the rotations of the engines. On each trip they were greatest in the vicinity of the after bulkhead of the superstructure.

Strains due to pitching and those due to the engines were distinguished by their periodicity. The engines made 78 rotations per minute, and the strains attributed to them were developed synchronous with the rotations.

For the purpose of determining the strains in the deck plates at the time of receiving cargo, reference lengths were established, of 20 inches each, on three courses of plating and on the bulwark rail of each side of the ship. These observations extended over a period of seven days, during which time a wide range in the temperature of the deck plates was experienced. The highest temperature was 116 degrees F., the lowest 60 degrees F. The greatest range in stresses occurred on the stringer plates—results ranging from 4,000 to 4,800 pounds per square inch being observed. The behavior of the deck was such as to lead to the belief that variations in temperature were responsible for the largest part of the stresses rather than being due to the cargo.

Apparently, a change in stress amounting to 2,500 pounds per square inch, occurred on the rail of the boat in rising from a temperature of 60 degrees in the morning to 90 degrees at the middle of the afternoon.

These last observations were generally made in the morning, about sunrise, to secure conditions when minimum differences in temperature existed.

Change of Shape of Recent Colliers

BY NAVAL CONSTRUCTOR STUART FARRAR SMITH, U. S. N.

ABSTRACT

This paper contains the results of observations of hogging and sagging on some of the 500-foot colliers recently built for the United States navy. It shows that the upper deck, at the middle of the length, may move up or down as much as 6 inches with reference to the ends, depending on the conditions of loading; and that a temperature rise of 1 degree F. may cause the deck to rise ⅛ inch. It contains some observations of the motion of the tank top with reference to the upper deck, and suggests that more extended observations of these points may permit of working backward from the girder deflection and loads to the actual fiber stresses, thus checking the preliminary strength calculations.

General Organization of Navy Yard Design, Location, Capacity and Maintenance, with Plan and Description of a Large, Efficient Yard Properly Located

BY CAPTAIN L. S. VAN DUZER, U. S. N.

ABSTRACT

This paper has been prepared to show that we must have at least one large navy yard where the entire fleet can be effectively repaired and supplied in time of war. That fact being admitted, the question is considered from the three principal

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points of view, viz.: (1) Suitability of location; (2) capacity of yard, and (3) cost of construction, maintenance and operation.

After considering the various requirements, it is pointed out that the position of New York is superior to all other ports on the east coast. It is, however, maintained that a better location may be obtained for the creation of a new navy yard at Communipaw, N. J., than is afforded by the present location in Brooklyn. The new yard would be a mile or two further away from an attack by sea and also close to all the great trunk lines of the country. It would still possess the advantages of the labor supply afforded the Brooklyn yard.

The great opportunity of designing a new, modern and up-to-date establishment for the construction and repair of ships is shown, and a tentative plan is presented. It is declared that the great expense of the new navy yard would be for the most part covered by the price obtained from the sale of the old navy yard.

Notes on the Performance of the S. S. Tyler

BY E. H. RIGG

This paper is published on page 29.

Historical Notes on Chain Cables

BY ASSISTANT NAVAL CONSTRUCTOR JOHN E. OTTERSON, U. S. N.

ABSTRACT

The above paper contains brief notes as to the history of chainmaking, as to the theory of stresses in the chain link; the relative advantages of open and stud-link chain, of end-welded and side-welded chain; a description of the present hand process of manufacture; the extent to which machine processes have been developed to date; and notes as to certain experimental work carried on at the navy yard, Boston, looking toward the development of a satisfactory machine process and toward the producing of chain of a more uniform and reliable quality. The paper also indicates the advantages to be gained by the proper heat treatment of the iron, and points to the necessity of more detailed and extensive study of this question.

Model Experiments and Speed Trials of 60-foot Motor Cruiser Kathmar II

BY A. E. LUDERS

ABSTRACT

Having been able to make a great deal of use of the various papers on the subject of resistance of ships and models read before this society, it has occurred to the writer that possibly similar data of a type of vessel that has not been touched upon in previous papers may prove of interest.

For this purpose the owner, Robert T. Fowler, Esq., of the 60-foot gasoline (petrol) cruiser *Kathmar II*, kindly placed this boat at my disposal, and a number of runs, results of which are plotted on a curve sheet, were made. To supplement this practical information the Navy Department most courteously agreed to make and test a model of this boat under similar conditions of draft—their interest making this paper possible.

The results of the model experiments as made by them are given on the same sheet as the other information.

The trials were over the New York Yacht Club course, 1.1 knots at Hempstead Bay, where four double runs were made.

Kathmar II was launched in the spring of 1911, at which time she floated—in light cruising trim—at her designed load water line. The difference of displacement on the 1913 trials is accounted for by the boat being deeply laden, preparatory to starting on an extended course, by soakage and the gradual augmenting of equipment, etc., that occurs from season to season.

The bottom of this boat had not been painted for three weeks, and was undoubtedly soft, though not foul. This probably explains somewhat the increase in horsepower over model experiments by an amount that indicates that the actual skin friction was practically double the theoretical.

The increased horsepower required to drive the boat with the stern cut off square at the waterline was unexpected.

The effective horsepower from trial was deduced from the thrust of the propeller (the wheel being deeply immersed, only 3 percent of wake was assumed), and using results of Prof. Durand's investigation (Vol. ——) as a basis from which to work by the laws of comparison of similar propellers. On the basis of a propulsive coefficient of 65 percent the horsepower at the 10.26-knot point agrees well with the brake test of the motor.

In general, the design of *Kathmar II* proved very satisfactory in seaworthiness and stability, and was somewhat faster than similar boats of the same power.

Some Graphic Studies of the Active Gyro Stabilizer

BY ELMER A. SPERRY

ABSTRACT

This work was undertaken to verify some observations made in connection with the sea trials of the active gyro stabilizer, which time did not permit of reproducing, and also to pursue some investigations further than was possible at sea, where it was felt that the sea characteristics were only at best roughly estimated, and where, for purposes of checking, their recurrence could not be secured. Again, a number of questions arose upon which more light was needed as to the exact behavior of the active gyro stabilizer; for instance, under widely varying phase relations of sea and ship, and also under widely varying conditions as to wave slope, general sea intensity, etc. In this way we have been enabled to verify, under conditions of much more extended observation, just what happens when the stabilizing capacity of the gyros is approached, exceeded and also far surpassed, and thus verify the results at sea.

Another important point is that with the new stabilizer no special problems whatever are introduced by the condition of synchronism or, in fact, any harmonic relation between the periods of the sea and ship.

Again, no small interest centers about the fact that with the active stabilizer no phenomena exist corresponding to the marked falling off in stabilizing capacity of damping tanks each side of the synchronous condition, nor in any phase relation possible between the waves and ship at which the active stabilizer is found to have the slightest tendency to add anything whatever to either the amplitude or the persistence of roll as do tanks.

It has been ascertained, also, that no alterations or adjustments of the gyro are necessary to fit changes in period of either sea or ship. The plant was found to work with equal reliability throughout the whole gamut of phase relation of wave slope and also under conditions of forced rolling.

Under the head of "Forced Rolling," that is, when the ship leaves her natural period and takes up the period of the sea, it is believed that never before has this interesting phenomena been studied where, for all practical purposes, the ship has been completely stabilized for all frequencies, and it is believed that an advance has been made in knowledge of forced rolling, and the conditions under which it invariably takes place.

The stabilizing efficiencies of the active model have been determined, confirming the high efficiencies observed in operating a full-sized plant at sea.

The unique action and dependability of the journals have also received confirmation.

The space and weight requirements, smallness of the power required, and the very low maximum stresses in the plant, as well as in the ship in the vicinity of the plant, have also received a valuable check.

The general reliability and simplicity of the system of velocity control have also received confirmation.

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Electric Propulsion on the U. S. S. Jupiter.

BY W. L. R. EMMET

This paper is published on page 30.

New Canadian Pacific Liner

The quadruple screw steamer *Empress of Russia* was built at Glasgow for the Canadian Pacific Railway Company's passenger service between the American continent, Japan and China. She left Liverpool on April 1 for the Pacific on a tour round the world with a large number of passengers. The chief particulars of the ship are:

Length over all	590 feet
Length between perpendiculars	570 feet
Breadth, molded	68 feet
Depth, molded, to shelter deck	46 feet
Gross tonnage	16,800 tons
Mean draft	26 feet 9 inches
Deadweight	7,000 tons
Speed on service	20 knots

The *Empress of Russia* was built by the Fairfield Shipbuilding & Engineering Company, Govan, to Lloyds rules for shelter deck type, and is classed 100 A–1. She has four continuous decks extending for the full length of ship, and at each end there is an orlop deck. Above the shelter deck a combined forecastle and bridge deck extends to well aft of 'midships, and is carried on open supports from 'midships to the stern. Above the bridge deck there is the promenade or boat deck, which extends between the masts.

The propelling machinery consists of Parsons turbines, driving four shafts. The two inner turbines are low-pressure, the port outer is a high-pressure turbine, which exhausts into the starboard outer turbine, which is the intermediate pressure. The two inner turbines are designed for driving the ship astern.

The four turbines are arranged in one room, which extends for full width of the ship. The condensers and auxiliary machinery are placed in the auxiliary engine room just aft of the turbine room.

Steam is supplied by six double-ended and four single-ended cylindrical boilers, having a total heating surface of 54,250 square feet and a total grate surface of 1,344 square feet, designed for a working pressure of 200 pounds per square inch. The boilers are arranged in three boiler rooms, and are worked under forced draft on Howden's system.

The electrical installation consists of four turbine-driven generating sets, each of 250 kilowatts capacity, while as a stand-by in case of complete breakdown of the main plant an 18-kilowatt generating set is installed on shelter deck above the waterline.

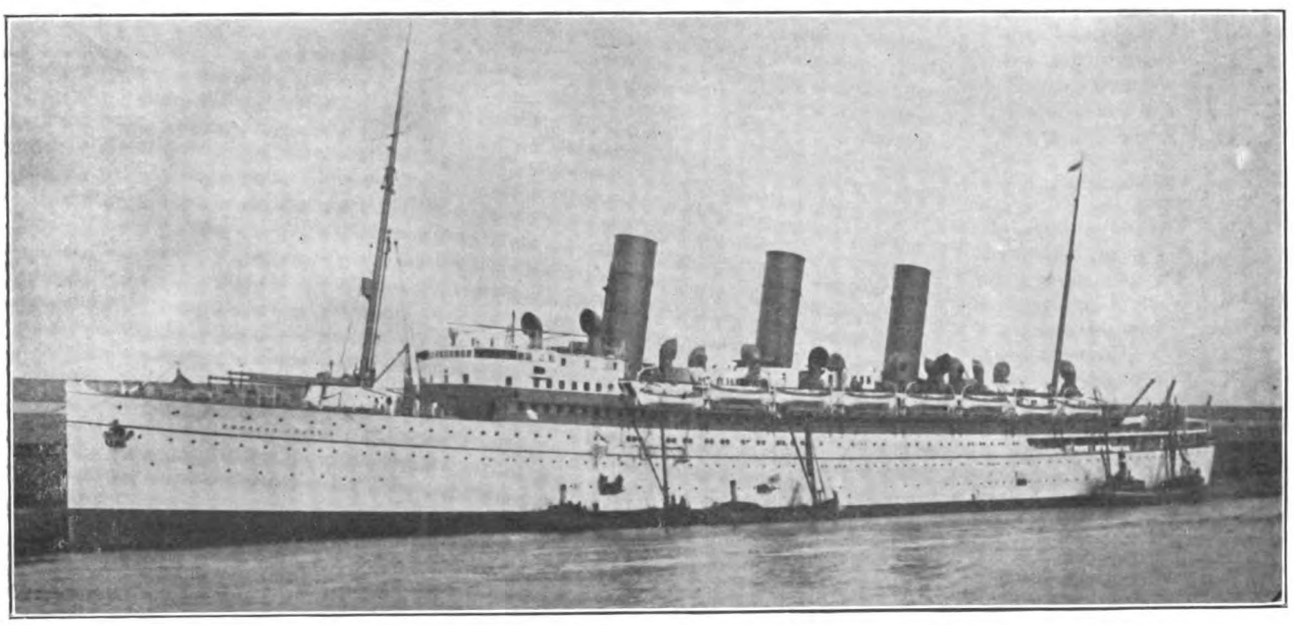
The ship is ventilated by the thermo-tank system; about twenty of these tanks are situated throughout the ship. To insure silent working the cargo cranes and winches are electrically driven. Wireless telegraphy and submarine signaling arrangements are provided.

Special attention has been given to the question of watertight subdivision, both in regard to the spacing and height of the transverse bulkheads and the provision of watertight flats, and it is claimed that the ship will remain afloat with any four adjacent compartments open to the sea. The watertight bulkheads extend generally to the shelter deck, a height of about 18 feet above the load waterline, and two of the bulkheads extend to the bridge deck. The coal bunkers are situated at the sides of the boiler rooms, and extend from the tank top to the main deck.

The *Empress of Russia* has accommodation for 200 first-class passengers, 100 second and 800 third class Asiatic passengers. The first class public rooms consist of dining saloon, library and writing room, lounge, card room, smoke room and veranda café, all of which are large and tastefully furnished. In addition there is a well-equipped gymnasium.

The *Empress of Russia* commenced her steaming trials on March 22. A series of progressive speed runs was made over the measured mile on the Clyde at speeds of from 12 to 21¼ knots. The contract required that runs up to 20½ knots should be made, and this was exceeded by ¾ knot. Following these progressive runs a further trial was carried out for a distance of 610 nautical miles. This distance was covered at an average speed of 20½ knots, which is ½ knot in excess of the contract requirements.

This is the first liner to have a straight stern like a warship, and the adoption of this type of stern has given very satisfactory results as regards speed, vibration, steering and sea-going qualities.



Quadruple Screw Steamer Empress of Russia. Equipped with Parsons Turbines, Maximum Speed on Trial 21¼ Knots

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Shipbuilding in the United States in 1913

New Merchant Vessels Chiefly for Domestic Trade—Shipping for Foreign Trade Continues to be Neglected—Greatest Activity in the Atlantic Yards—Warship Construction at Navy Yards Increasing—Lake Shipbuilding Marked with Unusual Dullness

Few people realize that at the present time the American merchant marine comprises a total of 7,886,518 tons, and that it is exceeded only by the merchant marine of Great Britain, which amounts to 18,696,237 tons. Germany is third in the list, with 5,082,061 tons. Unlike the British and German merchant fleets, however, practically all of the American merchant marine is engaged in the domestic trade.

There is much deserved criticism of the American Government for doing nothing whatever to foster the building and operating of vessels in the foreign trade. The shipbuilding and ship operating business is about the only industry that not only has not received encouragment, but that has been hampered in many ways by laws that are unreasonable and unjust. Every Congress for the last fifty years has made a more or less weak effort to further the interests of the merchant marine, but at no session has there been sufficient public sentiment or concerted action to accomplish anything.

As a result, there are less than a dozen ships in the foreign trade flying the American flag, and all of these are from ten to twenty years or more old. Furthermore, it is a question whether six of these ships are not operated contrary to law, because the control of the vessel so far as ownership is concerned is in the hands of people who are not American citizens.

To get some idea of what the possibilities of the shipping and ship owning industry would be if the Government would offer reasonable encouragement it is only necessary to see what has been done for the merchant marine in the domestic trade. Recent census reports show that the capital invested in shipyards within the borders of the United States represents practically $150,000,000 (£30,800,000) and that in these yards about $100,000,000 (£20,500,000) is spent annually in wages and for materials. The American merchant marine itself, in spite of its many handicaps, has expanded along the seacoasts and on the Great Lakes and other inland waterways until it represents a total investment of approximately $600,000,000 (£123,000,000). The yearly payments for wages, salaries, etc., are about $120,000,000 (£24,600,000) and repairs and renewals of vessels represent an expenditure of about $30,000,000 (£6,150,000).

If to the total of the American merchant marine were added the 2,000,000 or more tons of vessels now in the foreign trade owned by Americans, but operating under the flags of other countries because of the handicap placed upon vessels in such trade when flying the American flag, the total American merchant marine would be increased by this amount, bringing it up to nearly 10,000,000 tons. Furthermore, there would be an increase in the amount of the capital invested in shipping already quoted of about 33 percent, with corresponding increases in wages, salaries, money spent for repairs, etc., to say nothing of the taxes that would be collected on this tonnage. As some of the vessels in question are in the passenger service and others in the freight service, a unit of $75 (£15.4) per ton can be safely adopted as a valuation. This would represent $150,000,000 (£30,800,000) of American money invested in ships at the present time flying foreign flags, and yet not benefiting the American Government to the extent of one penny so far as taxes, etc., are concerned.

The Leading Shipbuilders

With the foregoing conditions in mind, it is of interest to examine the records furnished by the American shipyards, showing the amount of shipbuilding which has been carried out during the past year. While the following figures are by no means complete, since many of the smaller shipyards have failed to furnish the necessary data required to make such a record complete, nevertheless, the returns from the largest and most important shipyards in the country are complete and give a good idea of the extent of shipbuilding at the present time.

In Table I are given figures showing the number, gross tonnage and indicated horsepower of the merchant vessels built during the year by sixteen of the leading shipyards, while in

Table I—Merchant Construction

	No.	Gross Tons.	I. H. P.
American Shipbuilding Company	16	57,769*	31,740
Newport News Shipbuilding and Dry Dock Company	7	35,873	22,550
New York Shipbuilding Company	15	35,204	20,300
Maryland Steel Company	7	25,793	17,000
Wm. Cramp & Sons Ship and Engine Building Company	4	22,800	11,400
Harlan & Hollingsworth Corporation	9	13,747	14,760
American Car & Foundry Corporation	17	10,400	.....
Fore River Shipbuilding Corporation	9	10,315*	6,150
Great Lakes Engineering Works	12	9,888*	7,260
Ellicott Machine Corporation	7	4,000	.....
Union Iron Works	5	3,766	2,656
Manitowoc Shipbuilding and Dry Dock Company	6	2,778*	1,150
Seattle Construction and Dry Dock Company	4	2,642	8,070
Staten Island Shipbuilding Company	6	2,640	4,250
United Engineering Works	4	1,870	5,485
Bath Iron Works	1	306	275

Table II—Naval Construction

	No.	Tons Displacem't.	I. H. P.
Newport News Shipbuilding and Dry Dock Company	2	38,160	13,400
Maryland Steel Company	1	19,250	7,000
Mare Island Navy Yard	1	19,230	6,300
Bath Iron Works	2	2,040	32,000
Wm. Cramp & Sons' Ship and Engine Building Company	2	2,020	32,000
Seattle Construction and Dry Dock Company	1	1,838	1,600
Fore River Shipbuilding Corporation	1	1,010	16,000

Table II are given the number, displacement tonnage and indicated horsepower of naval vessels completed during the year 1913. From these tables it is evident that the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., produced the greatest volume of tonnage during the year, although the American Shipbuilding Company, comprising several yards on the Great Lakes, produced the greatest amount of merchant tonnage.

Shipbuilding Work at Navy Yards

In addition to the naval work in progress and under contract at the private shipbuilding establishments, two of the navy yards—the one at New York and the one at Mare Island, which are the only navy yards equipped for shipbuilding—are engaged with work to their maximum capacity. In fact, there is now a greater volume of new shipbuilding work in progress and authorized at these navy yards than ever before in the history of the new navy. At the New York yard the battleships *New York* and *No.* 30 are under construction, and at the Mare Island yard the river gunboats *Monocacy* and *Palos* and the fuel ships *Kanawha* and *Maumee* are under construction, while the electrically-propelled collier *Jupiter* has only just been completed.

Work in the Atlantic Yards

On the whole, the yards on the Atlantic coast have had a busy year, although the actual capacity of the yards is considerably greater than the amount of tonnage produced. At the

* Tonnage of non-propelled vessels not reported.

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Newport News yard, which is credited with first place, a number of large vessels were built, including the two naval colliers, *Proteus* and *Nereus*, of 19,250 tons displacement and 7,000 horsepower each; the Clyde liner *Lenape* of 5,179 gross tons and 3,600 horsepower; the Matson Navigation Company's passenger and freight ships, *Matsonia*, of 9,729 gross tons, 8,500 horsepower, and *Manoa*, of 6,850 gross tons and 4,000 horsepower. Other large freighters built included two bulk oil carriers, the *Illinois*, of 5,225 gross tons and 2,800 horsepower for the Texas Company, and the *Topila*, of 5,125 gross tons and 2,350 horsepower for the Southern Pacific Company. The freight steamer *L. K. Thurlow*, of 3,178 gross tons, 1,300 horsepower for the Crowell & Thurlow Steamship Company, and the bulk oil barge *Tamesi*, of 632 gross tons for the Southern Pacific Company, complete the list of vessels built at this yard during the year.

In addition to the above, a large amount of work is now in hand at the Newport News yard, including the battleships *Texas*, of 26,250 tons, and the *Pennsylvania*, of 31,400 tons. The Mallory freighters, *Meches* and *Medina*, each 420 feet 9 inches long by 54 feet 3 inches beam and 33 feet 9 inches depth, fitted with triple expansion engines of 4,100 horsepower; two large bulk oil steamers for the Standard Oil Company, each of which is about 475 feet long; an oil barge for the navy is also under construction and the freight and passenger steamship *Carolina* of the New York and Porto Rico Steamship Company is at the yard for remodeling of the hull and the installation of new machinery.

The New York Shipbuilding Company, which turned out practically the same amount of merchant tonnage as the Newport News yard, delivered during the year the passenger and freight steamer *Congress*, 7,985 gross tons, 7,000 horsepower, for the Pacific Coast Steamship Company; the Hudson River Day Line steamer *Washington Irving*, 3,104 gross tons, 6,000 horsepower; two bulk oil steamers for the Standard Oil Company, each of 3,663 gross tons and 1,900 horsepower, and a collier of 3,521 gross tons and 1,750 horsepower for the Coastwise Steamship Company. Other important vessels include the Old Dominion Company's freight steamer *Tyler*, of 3,928 gross tons, 1,750 horsepower, and the ferryboat *Santa Clara*, of 2,000 gross tons, which was built and shipped in knock-down form to the Southern Pacific Company. In addition to the above steam-driven vessels, eight car floats, ranging from 800 to 1,015 gross tons each, were delivered to various railroads.

The work now in hand at the yards of the New York Shipbuilding Company includes the Argentine battleship *Moreno*, 27,650 tons; the Chinese cruiser *Fei Hung*, 2,600 tons; the U. S. battleship *Oklahoma*, 27,500 tons, and four destroyers of over 1,000 tons each, besides the destroyer tender *Melville*, of 7,150 gross tons and 4,670 horsepower. The merchant vessels now under construction at this yard include the collier *Hampden*, of 4,727 gross tons, 2,100 horsepower, for the Coastwise Steamship Company; the ferryboat *Mayor Gaynor*, 1,075 gross tons, 1,950 horsepower, for the city of New York, and four car floats.

Although the Maryland Steel Company, which is the next yard on the list as regards the volume of merchant tonnage completed in 1913, does not usually undertake naval construction, nevertheless during the past year it delivered one naval collier, the *Jason*, of 19,250 tons displacement and 7,000 horsepower. The largest merchant vessels delivered from this yard were three freight steamers for the American-Hawaiian Steamship Company, each of which was of 14,495 tons displacement, 6,649 gross tons and 4,000 indicated horsepower. Two other interesting passenger and freight steamers, the *City of Annapolis* and *City of Richmond*, which are described in this issue, were built during the year for the Chesapeake Steamship Company. In addition to the above steam-driven vessels, two steel barges of 1,000 gross tons each were built for the Isthmian Canal Commission.

Three other freight steamers for the American-Hawaiian Steamship Company, sister ships to the vessels delivered in 1913, are now under construction by the Maryland Steel Company. This company also has in hand four more barges for the Isthmian Canal Commission, besides two railroad lighters and a tug. During the past year the Maryland Steel Company also installed in the Merchants and Miners steamship *Cretan* four Scotch boilers, 13 feet 6 inches diameter and 11 feet long.

Four freight steamers, three of which were of 6,000 gross tons and 3,000 indicated horsepower, and one 4,800 gross tons and 2,400 indicated horsepower, all for W. R. Grace & Company of New York, comprise the bulk of tonnage turned out last year by William Cramp & Sons' Ship and Engine Building Company, Philadelphia. Ten coal barges of 500 tons coal capacity each were built for the United States Government and the naval work included two destroyers, the *Aylwin* and *Parker*, of 1,010 tons displacement and 16,000 horsepower, both of which were equipped with Cramp turbines. Seven other destroyers, five equipped with Cramp turbines, and two with Parsons turbines, are now under construction at this yard, as well as the naval gunboat *Sacramento* and the submarine *G-4*, which will be delivered about the first of the year. Two freight and passenger express steamers, 524 feet long, 63 feet beam, 50 feet 6 inches depth to A-deck, of 10,000 tons displacement and 23,000 indicated horsepower, fitted with Parsons turbines, are now under construction as well as a car ferry, 350 feet long, for the Florida East Coast Railway Company.

The Harlan & Hollingsworth Corporation, Wilmington, Del., which does merchant work only, delivered during the year the Sound steamers *Narragansett* and *Manhattan* for the Central Vermont Transportation Company. These boats are of 3,540 gross tons, equipped with triple expansion engines developing 4,800 indicated horsepower. The ferryboat *Bayonne*, of 1,235 gross tons and 1,500 indicated horsepower, for service in New York harbor, and the ferryboats *Salem* and *Bridgeton*, of 774 gross tons and 700 indicated horsepower, both for service in Philadelphia harbor, were built at this yard, besides four car floats of over 800 gross tons each. In addition to the vessels, engines amounting to 2,360 indicated horsepower were built for hulls constructed elsewhere. The work now under construction at this yard for future delivery includes another ferryboat for Philadelphia and a sidewheel excursion steamer for service on Lake Pontchartrain. The gross tonnage of the latter is estimated at 700 and the indicated horsepower of the engines 600.

Boiler work forms an important part of the business carried on by the Harlan & Hollingsworth Corporation, and during the year 1913 no less than 24 boilers, aggregating 10,729 horsepower, were delivered and at present there are under construction for delivery in 1914 fourteen boilers, aggregating 6,393 horsepower.

In the Delaware district the American Car and Foundry Company, Wilmington, built a large number of small craft, including car floats, barges, scows and steamers, the approximate gross tonnage of which totaled about 10,400 tons. This company now has under construction four sea-going lumber barges, each 200 feet long, five car floats, each 250 feet long, and a dump scow, 144 feet long, the total approximate gross tonnage of these vessels aggregating about 8,050 tons.

Three steam trawlers 120 feet 6 inches by 22 feet 6 inches, of 253 tons gross and 450 indicated horsepower, were delivered in 1913 by the Fore River Shipbuilding Corporation, in addition to an oil tanker of 6,563 gross tons and 3,000 horsepower, and a bulk cargo steamer of 2,993 gross tons and 1,800 horsepower. Four car floats, each 340 feet by 38 feet, completed the amount of merchant work delivered from this yard during 1913. One naval vessel, the destroyer *Duncan*, 1,010 tons displacement and 16,000 horsepower, equipped with two Curtis turbines, was completed, and there are in hand the Argentine

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battleship *Rivadavia*, 27,600 tons displacement, 39,000 indicated horsepower; the battleship *Nevada*, 27,500 tons displacement, 26,500 horsepower; nine submarines and the submarine tender *Fulton*, 216 feet by 35 feet, equipped with a Nlesco six-cylinder engine of 900 horsepower, and two destroyers. All of the naval vessels under construction in this yard are to be equipped with Curtis turbines with the exception of the submarines and the submarine tender, where Diesel engines, supplied by the New London Ship and Engine Company, are to be installed. The freight steamers *Atlantic* and *Pacific*, of 5,500 gross tons and 2,100 indicated horsepower each, and the tank steamer *Amolco*, of 2,500 tons gross and 1,300 indicated horsepower, are under construction.

The Ellicott Machine Corporation, of Baltimore, built three pipe line steel hull dredges of about 900 tons each, one pipe line steel dredge of about 500 tons, one wooden hull pipe line dredge of about 300 tons, and two steel derrick lighters of about 250 tons each. This firm now has under construction two steel hull pipe line dredges of about 900 tons each, and a sea-going hopper dredge of about 1,000 tons.

Work at the Staten Island Shipbuilding Company completed in 1913 consisted of a 1,000-ton steel barge for the Standard Oil Company and five tugs, two of which were for the Standard Oil Company, one for the Texas Steamship Company, one for the Hamburg-American Line and one for the Hilton-Dodge Lumber Company. These tugs range in size from 173 to 452 gross tons and from 600 to 1,100 indicated horsepower. A United States torpedo testing barge of 615 gross tons was also built for the Navy Department during the year. This company has now in hand two railroad tugs and a large amount of boiler work. No less than fourteen boilers of various types are reported from this yard.

At the Bath Iron Works, Bath, Me., where most of the work done is for the United States Navy, two destroyers of 1,020 tons displacement and 16,000 horsepower, equipped with Parsons turbines, were completed in 1913, and two other destroyers, one of which is to be equipped with Parsons geared turbines, arranged on two shafts, are now under construction. During the last year the inland lake passenger and cargo steamer *Katahdin*, 115 feet long over all, 29 feet beam, 9 feet depth and 306 tons gross, fitted with a compound engine of 275 indicated horsepower, was delivered to the Coburn Steamship Company and an order has just been received for the construction of a cup defender for the 1914 America cup races.

At some of the smaller yards a considerable amount of tonnage was produced in the form of small vessels of various types. The Skinner Shipbuilding and Dry Dock Company, of Baltimore, built two tugs and did some boiler and engine work for other tugs and steamships.

The Spedden Shipbuilding Company, Baltimore, built the fireboat *Cataract* for the city of Baltimore. William E. Woodall & Company, of Baltimore, completed a car float of 684 tons for the Baltimore and Ohio Railroad Company, and now have under construction a sea-going barge of about 1,200 tons for P. Dougherty & Company, of Baltimore. At the plant of the E. J. Codd Company, Baltimore, the marine work consisted chiefly of engine and boiler work, two compound engines and three boilers having been completed.

In the New England district the G. G. Deering Company, Bath, Me., built the five-masted schooner *Courtney C. Houck*, 218 feet 9 inches long, 42 feet 7 inches beam and 24 feet 6 inches depth. This vessel has a gross tonnage of 1,627, a net tonnage of 1,357 and a cargo-carrying capacity of 2,500 tons. The Portland Company, Portland, Me., built two fishing steamers, one 150 feet long overall, equipped with a 450 horsepower engine, and the other 185 feet long overall, equipped with a 900 horsepower engine, and the towboat *Charles P. Greenough*, which was described in the last issue of INTERNATIONAL MARINE ENGINEERING. A 250 horsepower towboat engine was also built by them. The Portland Shipbuilding Company, Portland, Me., has under construction a barge of 250 gross tons and a steamer of 233 gross tons, fitted with a 450 horsepower triple-expansion engine.

One of the largest Western river boat builders is the firm of James Rees & Sons, of Pittsburg, who built last year two boats for South American service, one of 150 tons and the other 300 tons. The work now in hand at this yard includes two shallow draft vessels of 150 tons each, while a considerable amount of additional boiler work has been done during the past year and is now in hand for early delivery.

SHIPBUILDING ON THE LAKES

The past year in lake shipbuilding has been marked with unusual dullness, which is reflected by the comparatively small number of ships built. General repair and drydock work, however, has kept the yards fairly busy until the early part of November, when the disastrous storm swept the lakes, and since then, owing to the unusually large amount of damage sustained by a number of lake vessels, a large amount of repair work has been required. This work, together with considerable hull reconstruction and several large re-boilering jobs, has improved the prospects for the winter in general repair work, and the unusual number of total losses in the fall of 1913 has brought out a number of inquiries for figures upon new tonnage, some of which has been contracted for.

Notable among the ships built on the Great Lakes during the year 1913 may be mentioned the passenger steamers *See and Bee*, *North American* and *Noronic*. The first two ships have been fully described in previous issues of INTERNATIONAL MARINE ENGINEERING, and a more complete description of the steamer *Noronic* will appear in a later issue. This ship was built for the Northern Navigation Company for the run from Sarnia to Duluth by the Western Dry Dock and Shipbuilding Company, of Port Arthur. Her principal dimensions are: Length over all, 388 feet; length of keel, 363 feet; beam, 53 feet; depth, 38 feet 9 inches. The boiler plant consists of four main boilers, 15 feet 6 inches diameter by 11 feet long, built for 200 pounds working pressure and one donkey boiler, 12 feet 6 inches diameter by 11 feet long. The main engine is a four-cylinder triple-expansion engine, 29½, 47½, 58 and 58 inches by 42 inches stroke.

Among the freight vessels constructed during the year the prevailing type was for the bulk freight trade and one of these ships, the *James Carruthers*, the largest vessel built in Canada to date, was lost with her entire crew in the storm on Nov. 9.

The coming year shows no sign at present of being an unusually active one in lake shipbuilding, but it should prove up to the general average commensurate with conditions throughout the country, which, of course, are always reflected in this as well as the other industries.

Of the lake shipbuilding firms, the American Shipbuilding Company produced the greatest amount of tonnage, and, as before noted, this firm holds the record for building the largest amount of merchant tonnage in the country. Four sister ships of the bulk freight type, 600 feet long, 58 feet beam and 32 feet depth, with a tonnage of 7,705 and an indicated horsepower of 1,880 each, were built for the Pittsburg Steamship Company. The bulk freighter, *Alton C. Dustin*, with a tonnage of 7,978 and an indicated horsepower of 1,750, was built for the Franklin Steamship Company. Two bulk freighters of 1,706 tons and 900 indicated horsepower were delivered to the George Hall Coal Company and three oil tank steamers of 2,486 tons and 1,650 indicated horsepower each and three oil tank barges of 2,441 tons each, were built for the Standard Oil Company. Two notable passenger and freight steamers, the *See and Bee* and *Noronic*, which have already been noted, form a part of the output of this concern, while the remaining vessels included a packet freight steamer of 2,326 tons and 900 indicated horsepower for the Canadian Interlake Line,

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Ltd., and a stern wheel passenger and freight steamer for the Canadian Pacific Railroad.

The next largest producer on the lakes was the Great Lakes Engineering Works, where the steel packet freight steamer *Boston*, of 4,184 tons and 1,760 indicated horsepower, was built for the Western Transit Company, the passenger steamer *North American*, of 2,317 tons and 2,000 indicated horsepower, for the Chicago, Duluth and Georgian Bay Transit Company, and a steel car ferry of 2,670 tons and 2,500 indicated horsepower for the Grand Rapids and North Western Railroad. Four of the producer gas coal barges for the Alabama and New Orleans Transit Company were finished during the year, while construction on nine similar barges for this company is rapidly progressing. The output of the Great Lakes Engineering Works also included the hulls for two dredges, a steel grain lighter and a steel flat lighter.

At the Manitowoc Shipbuilding and Dry Dock Company three dredges of different types, one a dipper, the second a suction and the third a hydraulic dredge, were built, besides two car floats and a tug for the Erie Railroad, described in a previous issue of INTERNATIONAL MAGINE ENGINEERING.

At the Toledo Shipbuilding Company, the ferry *Essex*, 105 feet long, propelled by a 500 horsepower inverted high-pressure engine, was built for the Detroit and Walkerville Ferry Company.

Three of the Canadian yards, the Collingwood Shipbuilding Company, the Kingston Shipbuilding Company and the Polson Iron Works, completed several smaller vessels of miscellaneous types, including dredges, scows and a passenger and freight steamer. As previously noted, the first of these firms built the large freighter *James Carruthers*, which was lost in the November storm.

PACIFIC COAST YARDS

On the Pacific Coast the principal yards have in hand a considerable amount of naval work, although only a few naval vessels were completed in 1913. At the Union Iron Works two submarines were delivered, while the merchant vessels built at this yard consisted of two lumber carriers, one of 1,600 gross tons and 1,358 indicated horsepower, and the other of 1,456 gross tons and 1,178 indicated horsepower, an oil tanker and an oil barge for the Standard Oil Company, and an oil barge for W. D. Ayers. The Union Iron Works now has under construction a large oil tanker for the Associated Oil Company, which will have a tonnage of 6,430 and an indicated horsepower of 2,400.

At the Seattle Construction and Dry Dock Company's yard the year's production was varied, including two submarine boats, one for the Chilian Government and the other for the United States Government. The other government work completed consisted of nine steel coal barges and the suction dredge *Colonel P. S. Michie*, of 1,838 gross tons and 1,600 indicated horsepower, for the United States Government. Of special interest in the merchant work produced in this yard during the year were the day passenger steamer *Tacoma*, of 836 gross tons and 3,760 indicated horsepower, built for the Inland Navigation Company, and equipped with Ballin water-tube boilers and four-cylinder triple-expansion engines; the steam yacht *Cyprus*, of 1,037 gross tons and 3,000 horsepower; the cargo steamer *Comanche* and a tug for the Milwaukee Terminal Railroad Company.

The work now in hand at the Seattle Construction and Dry Dock plant consists wholly of government work, including three tugboats, one submarine and the submarine tender *Bushnell*, for the United States Government, and a submarine for the Chilian Government. The submarine tender *Bushnell*, by the way, is to be fitted with geared turbines and Yarrow boilers.

Four vessels aggregating 1,870 gross tons and 1,430 indicated horsepower were turned out by the United Engineering Works, while machinery for vessels other than those built by this company was delivered, aggregating 4,055 horsepower.

Other vessels built on the Pacific Coast include the fast ferryboat *Edward T. Jeffery*, which the Moore & Scott Iron Works built for the Western Pacific Railroad, and the side-wheel ferry *Leschi*, of 477 gross tons and 700 indicated horsepower, which J. F. Duthie & Company, of Seattle, built for the Port Commission of Seattle.

ANNUAL REPORT OF THE SECRETARY OF THE NAVY.—In his annual report for the fiscal year 1913, the Secretary of the Navy recommends the authorization by the present Congress of two dreadnoughts, eight destroyers and three submarines as the building program for 1915. This is contrary to the recommendations of the General Board, which proposed the construction of four battleships, sixteen destroyers and one destroyer tender, eight submarines and one submarine tender, two oilers, two gunboats, one transport, one supply ship and one hospital ship. The Secretary further states that the time has come when the department should be freed from excessive prices charged by private manufacturers of armor plate, guns and gun forgings, powder, torpedoes and other supplies and munitions, and he recommends that provisions be made for an armor plate factory, and an increase in the gun factory, the powder factory and the torpedo works. At present there are only three firms in America which can manufacture armor plate and bids for armor plate from these firms seldom vary over a few dollars, being in every case an excessive price. The Secretary maintains that the Government can achieve a saving by the erection of a 10,000-ton-a-year plant of $1,061,360 (£217,500) per annum after deducting 4 percent as interest on the money used in erection and installation of the plant, and $3,048,462 (£625,000) a year on the basis of a Government plant capable of producing 20,000 tons a year. The Secretary further recommends to Congress the consideration of providing fuel oil for the navy at reasonable rates and the passage of legislation that will enable the department to refine its own oil from its own oil wells and thus relieve itself of the necessity of purchasing what seems fair to become the principal fuel of the navy in the future at exorbitant and ever-increasing prices from the private companies that now practically control the supply. While at present only a portion of the United States Navy is equipped to burn oil, nevertheless the navy is using this year 30,000,000 gallons of oil, and there is every likelihood that this amount will be increased to 125,000,000 gallons in the future. Every gallon of this must be purchased from the oil companies at their own prices until Congress relieves the department by proper legislation.

ANNUAL REPORT OF THE UNITED STATES REVENUE CUTTER SERVICE.—Summarizing the lengthy annual report of the United States Revenue Cutter Service, E. P. Bertholf, captain commandant, states: "The winter season of 1912-13 was of unusual mildness compared with the severe weather of the previous winter, but the occurrence of several gales along the coast, together with accidents to ships from other causes, called forth the usual vigilance and activity of the fleet of revenue cutters and the result of these operations of the service during the past fiscal year shows that $10,626,010 (£2,180,000) worth of property has been saved from the perils of the sea and that there have been 327 lives saved or persons rescued from danger. As the total cost for the maintenance of the service during that period was $2,471,532.51 (£507,500), the year's efforts produced a consummation of $4.29 (17/11) for each dollar thus invested by the Government. Twenty-five cruising cutters and 18 harbor vessels and launches were actively employed in the service during the year.

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Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdown at Sea and Repairs

A Stranded Engineer Repairs a Crippled Engine

When I used to go to school, and that's a long time ago, the teacher told us boys that if he took a tub of water and dropped a lot of little chips all around on the surface, pretty soon they would all be sticking to the sides of the tub or gathering in little clumps. He called this "capillary" attraction, and I used to amuse myself trying it, always finding that it was so, which rather goes to prove that I didn't always believe what my teacher said.

There are a whole lot of men that are floating around in this tub of a world, especially that part of it in which I have knocked about—the West Indies—and you find some of them sticking along the edges of the Spanish Main and Gulf and in little groups on various islands. I have been one of these floaters, and once upon a time I found myself flat broke, down to 60 cents (2/6), on the coast in a little village where there was nothing for me to do and no way that I could see of getting out of the place.

But luck, as we call it, came to my aid, and when I had reached the 60-cent (2/6) condition a little steamer dropped anchor off shore, and the captain came in to look after a cargo of bananas that he was to pick up there. I kept my eye on him and as soon as he landed he struck trouble.

He couldn't speak Spanish, and the two darkies that rowed him ashore spoke only French, and such French! There was my chance. When he began to "holler" in English I knew he couldn't speak Spanish, and it's a queer thing that people seem to think that if they "holler" loud enough in English any foreigner will understand them, and when that doesn't work they start in with broken English or baby talk.

Well, I got hold of the captain; and as I spoke Spanish, I got him out of his troubles, and all the time I was helping him I was wondering how I could get a job aboard his tub of a boat. But he helped me out by asking me if I knew anything about machinery, and when I told him I was an engineer he almost fell on my neck. His boat flew the flag of a country that didn't have any Board of Supervising Inspectors or any laws that I ever heard of about safety at sea, so he only had one engineer, and he was sick, and there was trouble with the engine. We struck a bargain at $100 (20/16/8) a month, or any part of it, and in half an hour I was on board. The engineer was sick and there was nobody to look after him. I started the cook making some good soup for him out of turtle meat, and I made him some hot tea, until he was able to tell me that the engine, on account of his illness, had been run by the oilers, and was in very bad shape.

I went below and looked over the engine. The only serious trouble seemed to be in the high-pressure valve-stem head. This was forged on the valve stem, as shown in my sketch, Fig. 1. The eyes in the two lugs were worn by the link block pins, so there was half an inch play on one side and one-eighth of an inch play on the other. In fact, one of the lugs was almost worn through. The holes in these lugs had originally been bushed, but where the bushing had gone I couldn't find out.

There were no tools aboard the boat of any kind beyond a ratchet and a few drills and a grindstone, which had no frame, and you could only wear off a drill by rubbing it on the side of the stone as it lay on one of the benches. I got the valve stem out, and luckily discovered in a drawer a hack-saw and several new blades. I hunted around and found a piece of boiler iron about eleven-sixteenths thick, and this is how I fitted up the same:

First, I hack-sawed off the two lugs, leaving the head as shown in Fig. 2. I had, fortunately, found a number of files which belonged to the chief personally. I filed up the two sides of the valve-stem head and laid it one side. Then, after a long hunt, I came across four good cold chisels, also the property of the chief.

Out of the eleven-sixteenths steel I made two lugs, as in Fig. 3, which, of course, were to a certain extent like those I had cut off from the valve-stem head. The vise which was on board the boat was in pretty good condition, and with it and my files I worked out these two lugs as shown. The recesses

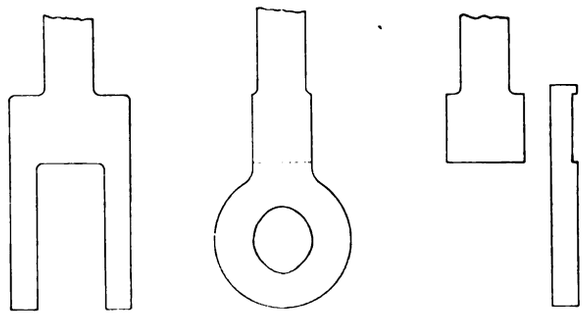

Fig. 1 Fig. 2 Fig. 3

I fitted with a good deal of care to the valve-stem head. When I got these fitted so they would drive on with a piece of lead I started to hunt up some tool steel to make a small drill to drill a hole through the lugs in the head to hold them in position.

But here I was stuck. First, because there was not a piece of tool steel aboard of any kind except my files; second, I had nothing that I could use for drilling a small hole. But, mussing around, I found a piece of tubing, probably one of the boiler tubes, and by filing off the corners of the lugs I could force this piece of boiler tube down over them, forming a sort of collar, and thus hold them firmly in position. I was afraid this might work off, so I wired the collar to the head by passing a wire underneath the head and up over the sides of the collar and down, twisting the ends together.

Next I poured babbitt into the four openings made by the collar around the head and lugs. When this was cool I found I had a pretty firm job, and now the question was to get the holes in these lugs true and of a size to fit the pin in the link block. The parts of this pin against which the lugs of the valve stem had worked were considerably worn, but more battered. I dressed the pin all up carefully with a file, and then I was in trouble for some bushings.

There wasn't a piece of brass or composition aboard the ship that I could find except some sheet metal about a good sixteenth of an inch thick. After thinking the matter over I made up my mind I could use this sheet brass, but first I had to get the holes in the lugs. If I remember rightly the link-block pin was about one and a quarter inches in diameter. I found an inch and seven-eighths twist drill, and rubbing it upon the grindstone the best I could I started in to rig up to drill the two holes in the lugs.

The ratchet drill was in good shape, and I took the valve

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stem to the top of the engine cylinders where I could get a true surface, and after a good deal of trouble I got the valve stem strapped down true and an "old man" rigged up by slacking off some of the nuts on the cylinder studs, and so making fast its foot, and without much difficulty I got moderately straight holes through the lugs.

Now to make the bushings, I cut strips of the sixteenth metal as wide as the length of the block pins. I curled this strip up until I had enough metal to be sure to fill the holes in the lugs of the valve stem, and with a hole in the middle small enough to allow filing it out to fit the link-block pins. I soldered these two rolls of metal, as I found plenty of solder on board and some acid, and with a whole lot of work with a file I made something like a fit on the link-block pin and a very good fit on the outsides of the bushes in the holes of the lugs. I put the valve stem in position, and with a little more tinkering I got everything in position and felt pretty well satisfied.

This work had taken considerable time; in fact, it took me the best part of three days, during which time the chief, under my care, was doing better, and he told me about how fast the vessels could be driven. I figured out that my spiral bushings, if I kept them cool, would probably last out until we got into some port where a proper job could be made of the work. We got away the following day, and by keeping one of the oilers constantly on the watch, we made our port without any mishap, much to my relief; but when I went to the captain to go ashore and get material and have some bushes made, there was "nothing doing."

We would have to get out at once, and he thought the repairs would last out. He was right, and a week after we dropped anchor over at Jackmel, and I was ready to quit; mostly because, after looking over the boiler, I made up my mind that as both the oilers and firemen were Haytian darkies, I would certainly become pretty well mixed up with them when the boiler let go, which it was sure to do before long.

So I got the chief ashore, and in a few days we both took steamer to Kingston, and there I am now, and I suppose that I shall always be floating around this part of the world unless this "capillary" affair draws me back home.

Kingston, Jamaica, W. I. BREAKDOWN JOHNNY.

The Value of Trade Literature

I have written to and received catalogues and other literature from 43 percent of the advertisers in INTERNATIONAL MARINE ENGINEERING. Most all of the material which came to me was of considerable interest and value to me in my vocation as an instructor in steam and marine engineering, and that material is on file. In these days, catalogues, circulars, etc.—particularly those pertaining to engineering matters—*are of as much value as are text-books,* and in some instances more.

In my opinion the difference between text-books and first class catalogues is this: Text-books deal in, and treat of, elements and principles *in the abstract,* while catalogues deal in and treat of *concrete applications* of elements and principles to a given product. I am not undervaluing in the least text-books; they have an important place in the educational world. But none the less important are trade catalogues in the educational world as well as in the world of commerce.

No engineer or other person at all interested in the products of the various advertisers in INTERNATIONAL MARINE ENGINEERING can afford to ignore either the advertisements which appear from time to time, or the catalogues which are proffered the readers, whether or not they are prospective purchasers. No wise engineer does ignore them. No person can quite keep up to date, or down to date—whichever way we may say it—*unless he reads the ads. regularly and studies the catalogues and other literature* to be obtained. *Text-books alone will not keep us up to date* and cannot be expected to do so in the very nature of things. Catalogues can and do keep their readers well posted, and from all viewpoints I do not know just how we would get on without them. While I have quite a few text-books, and prize them, *I have a great many more catalogues because I need them.* This is not because they can be obtained for the asking, but because they are *really more useful* than are text-books, *after one has learned abstract elements and principles,* which do not change, but whose *applications* are almost continually changing.

Scranton, Pa. CHARLES MASON.

Wentworth Engine vs. the Hot Tube Type

On page 173 of the April number of INTERNATIONAL MARINE ENGINEERING was published a criticism of my engine which was of a nature hard to ignore. Mr. J. Barraja-Frauenfelder is the critic and his statement is generally incorrect. His statement divides into two parts:

1. He says my engine or the matter of preheat is not new.
2. He asks for more facts about the engine.

In my connections with the engineering profession for the last few years on this line of work I have found the attitude of Mr. Frauenfelder to be quite a common one; that is, to make authoritative such statements as are needed to support a certain argument and to deny arguments to support the opposite side of the question. This particular part of my present statement may not be very interesting to Mr. Frauenfelder, but I think that it may to other readers.

In the days of the first Diesel Engine Company of America the engineer-in-chief abruptly, positively and without the possibility of contradiction told me "That the exhaust of the Diesel was cold." The engineer in charge of assembling and testing the engines at Providence later assured me of the same fact. This latter man was offended that I should contradict him when he was handling the engines and I was not. At this time I was working on a constant pressure type of engine and I felt that if they could prove me wrong in something they knew about there would be reason for them to doubt what I told them in my own line. I submitted proof of my statement of the temperature of the exhaust of the Diesel and was met with the statement "That the engine worked and that was all they cared about." A leading shipbuilding company in the course of an examination into my work with relation to taking out a license turned me over to an engineer. This man finally rested his argument against the engine on the basis that a steam engine could be built for $12 (2/10/0) per horsepower and my engine would cost $40 (8/6/8) per horsepower. "How could the ship owner be persuaded to pay this difference?" Investigation shows that $12 (2/10/0) per horsepower means simply the engines without boilers, etc. The statements of Mr. Frauenfelder are of the same nature as the examples given.

PREHEAT

This word is made up of the word heat with the Latin prefix pre, meaning before. The air in the Wentworth engine is heated before the suction stroke begins. This method I have originated. If. Mr. Frauenfelder has proof to the contrary I think that it would interest the U. S. Patent Office, which has been investigating this question for some time.

THE WENTWORTH ENGINE

At full load the Wentworth engine operates on the De Rochas cycle and can start at a minute's notice so long as there is a supply of energy for starting purposes. At partial loads, say two-thirds load, the thermodynamic operation of the Wentworth engine is the operation of the full stroke of the engines which Mr. Frauenfelder calls the semi-Diesel. The clearance of the Wentworth engine will bear the same relation to the two-thirds of the total cylinder volume that the clear-

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ance of the engines mentioned by my critic bears to the whole stroke of their engine cylinders. In other words you can superpose a hot tube or hot bulb type indicator card on the card from a Wentworth engine at two-thirds power, and when the hot bulb engine is exhausting the Wentworth engine will still have an expansion of the hot gases half as far again as they expanded in the hot bulb engine.

I think that this will answer my critics.

Soot

Mr. Frauenfelder tells us that the substance which is deposited is not soot, but is "half baked particles of fuel or residual carbon." To me a rose smells as sweet under any other name. I was under the impression that his compound would be known as soot to the unlearned.

Source of Preheat

I think that the contention which I made years ago that the exhaust of the Diesel engine was around 1000 degrees F. has been recognized as correct. Fig. 1 is the card I used to investigate the temperatures of the Diesel engine. Owing to the fact that your subject is a perfect gas you can get your temperatures by calculation from this card. The Diesel theory was to prevent an essential increase in temperature. (I mean an increase over the compression temperature.) It was my idea that they were wrong and that they should increase the temperature as high as possible. The only reason for not increasing the pressure is purely practical. I have been recently informed by the Diesel interests in this country that this is now done. This is done by the method of feeding the fuel. The top of the card is level for an appreciable part of the stroke and the mean effective pressure is increased to, say, 125 pounds from the old pressure of 100 pounds.

In starting the all-round Wentworth engine the engine must be started on the De Rochas cycle till the exhaust pipes have become heated. As soon as they become heated the preheat needed for a reduction of compression pressure will come from the exhaust gases. If it is desired to build an engine in which the compression shall never be higher than, say, 250 pounds, then it is necessary to use an external means (a hot air furnace, for instance) to provide the needed preheat. This will be more expensive than the method used in the hot bulb type and will take just as long to start. However, in this case you will still have a choice of temperatures and in such an engine the partial load compression can be brought down to, say, 175 pounds.

The crowning glory of the old, reliable and (in these days) almost despised reciprocating steam engine lies in the fact that it always goes and the only complaint which it makes is that which Kipling so well describes through the old engineer, McAndrews. My aim has been to weld into one machine the efficiency of the De Rochas cycle and the reliability and flexibility of the steam engine. It was with this aim in view that I worked on the constant pressure type which I have abandoned for the Wentworth cycle, which allows of an economical cutoff and of a greater range of fuel injection than is possible in the De Rochas cycle.

Suppose an efficiency contest be arranged under the following points:

1. Ten for the maximum output.
2. Ten for the maximum efficiency at full load.
3. Ten for the maximum efficiency at partial loads.
4. Ten for the maximum revolutions per minute.
5. Ten for the minimum revolutions per minute.
6. Ten for rapidity of start.

All engines to have the same stroke and bore.

In Test No. 1 the Wentworth and conventional Diesel would be tied. Both using cold air to compress could consume more oil without imperfect combustion than could the hot tube engine. The two cycle would show more power for the same bore, stroke and number of working cylinders.

In Test No. 2 if all engines are of perfect design and workmanship they should be tied, except the two cycle, which is less efficient.

In Test No. 3 the Wentworth engine, owing to its increased expansion over either the Diesel or hot tube engines, should easily lead by a very evident margin.

In Test No. 4 again the engines would be on an even footing with the workmanship considered equal.

In Test No. 5 the Wentworth engine would again show up well. Assuming that both the conventional Diesel and the hot tube type are properly designed there will be no great excess of temperature at the end of compression. Now as the engine begins to slow down in speed the radiation loss at the end of compression for the conventional Diesel will increase

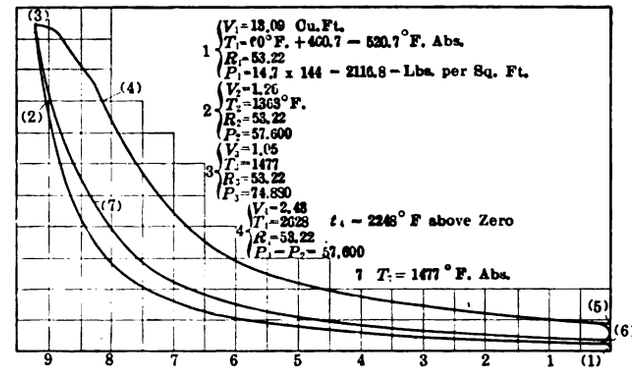

Fig. 1

till soon the temperature at the end of compression will be less than the igniting point and then the engine will stop. By means of a high preheat to the air and a retarding of the fuel injection the Wentworth engine should lead the conventional Diesel and push the hot tube type hard.

In Contest No. 6 the conventional Diesel, two cycle and the Wentworth would start without any notice, while the hot tube type must be worked over for a considerable time before it would start.

Summary

Test.	*Wentworth*	*Conventional Diesel.*	*Hot Tube Type.*	*Two Cycle Engine.*
No. 1	8	8	7	10
No. 2	10	10	10	9
No. 3	10	8	8	7
No. 4	10	10	10	10
No. 5	10	8	10	8
No. 6	10	10	7	10
Totals.	58	54	52	54

This comparison ignores the question of practicability to build a hot tube engine of large size, such as can be done with the other engines. In the 2 cycle engine the scavenging arrangement is ignored.

I trust that this clears up Mr. Frauenfelder's doubt as well as the doubts of others.

Quincy, Mass. JOHN F. WENTWORTH.

INLAND WATERWAYS.—Pleas for sufficient appropriations by Congress to complete the proposed inland waterway route along the Atlantic coast were brought forward at the annual meeting of the Atlantic Deeper Waterways Association held in Jacksonville, Fla., recently. The urgent need for the improvement of an inner trade route along the coast was emphasized and recent destructive coastal storms were pointed out as an argument in favor of the project. The need of a broad policy and of co-operation between the Federal Government and the States to secure improved waterways was also the keynote of the discussion at the National Rivers and Harbors Congress held in Washington in December. Better waterways and improved marine terminals are an urgent need in America.

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Marine Articles in the Engineering Press

Thornycroft Watertube Boiler for Oil Fuel.—The latest type of Thornycroft watertube boiler, especially designed for torpedo destroyer work, embodies several novel features which have been introduced both to save weight and to increase efficiency. Oil fuel only is used, which is sprayed into the furnaces on the Thornycroft system. The heating surface on the boiler is 6,300 square feet. Both upper and lower barrels are of seamless steel and cylindrical in shape. The bottom ends of the tubes are slightly curved to allow for expansion and retain the cylindrical form of the mud drums. With the Thornycroft oil burning system the builders guarantee an equivalent evaporation of at least 16½ pounds of water from and at 212 degrees per pound of oil per hour if the rate of evaporation does not exceed 4 to 5 pounds per square foot per hour, and they further guarantee a maximum output of 16 pounds per square foot per hour from and at 212 degrees, with an evaporation of 14 pounds of water per pound of oil. 3 illustrations. 500 words.—*Engineering*, October 24.

The Fried. Krupp Germania Shipbuilding Yard, Kiel.—From a very early period in the history of German shipbuilding the Krupp metallurgical and ordnance construction works were in close connection with the shipbuilding yards, supplying ordnance and mountings, armor, crank and propeller shafts, heavy steel castings and iron and steel plates. These at first were manufactured at Essen for delivery to German yards owned by other German firms. When, however, the Essen establishments decided, in the early nineties of the last century, to manufacture basic steel on a very large scale, they placed themselves in a position to undertake also the construction of ships of all classes complete, and therefore resolved to purchase a yard for the purpose. The Germania yard had been established since 1863 and had frequently changed hands. The vessels were built at Kiel, but the engines were built at the Tegel Works, near Berlin, then owned by the Schiff und Maschinenbau A.-G. Germania, from whom Messrs. Krupp first leased and then purchased the yard. The yard was thoroughly reorganized and greatly enlarged, the entire engineering works being transferred from Tegel to Kiel. The reconstructed plant presents a very modern and splendidly equipped shipyard with the various departments thoroughly coordinated. The arrangement and equipment of some of the principal shops, such as the pattern shop, boiler shop, electric power plant and main engineering building, are described in some detail in the article. The launching ways, of which eight are provided, vary in length from 380 to 633 feet. The largest of the building slips can accommodate a battleship 820 feet long and 130 feet wide. The ways are of concrete, hollow and of rectangular shape. Their floor, which is on an incline of 1 in 18 and 23, is at their outer end at a depth of about 9 feet 6 inches below the sea level. Each slip is closed at the end which gives into the sea by a floating pontoon, an arrangement which does away with a slide beyond the ship. Four of the slips are covered over by a glazed roof carried on latticed columns, while three of the ways are open. The yard employs about 7,000 men. 13 illustrations. 3,500 words.—*Engineering*, November 7.

Royal Holland Lloyd Liner Gelria.—Messrs. Alex. Stephen & Sons, Ltd., Linthouse, have under construction for the Royal Holland Lloyd Line two mail and passenger steamers for service between Holland and South America. These are the *Gelria* and *Tubantia*, sister ships, 560 feet long, 66 feet beam, 39 feet depth, with a gross tonnage of 14,053, propelled by quadruple expansion engines with cylinders 28, 40, 57 and 82 inches diameter, with a common stroke of 54 inches and using steam at 220 pounds pressure supplied by three double-ended and six single-ended Scotch boilers, working under Howden's system of forced draft. On trial the *Gelria*, with her engines developing 12,000 indicated horsepower, obtained speeds over the measured mile ranging from 16½ to 17½ knots. The bunker capacity is 2,400 tons and the cargo capacity 9,000 tons. Accommodation is provided for 250 first class, 230 intermediate class, 140 special third class, and 900 third class passengers. The hull is subdivided by five structural decks and nine transverse watertight bulkheads, together with a complete double bottom designed for carrying over 2,000 tons of water ballast. 1 illustration. 1,500 words.—*The Engineer*, October 24.

A New Mounting for Big Naval Guns.—For the benefit of readers unfamiliar with the intricacies of turret construction and gun handling, the general features which are to be found in most modern mountings for big naval guns are described in some detail. Attention is then directed to a new type of gun mounting which has been made by Sir W. G. Armstrong, Whitworth & Co., Ltd., for a battleship which is now under construction at the Elswick Shipyard for a foreign power. The improvements in this mounting lie mainly in the direction of rapid working, but combined with this is economy of gun crew and simplicity of operation. The main feature of the mounting is that one lever works all the machinery in the turret and thus replaces four levers formerly used. The one lever performs the various operations in rotation by working around the four sides of a square, the motion along each side performing a distinct and separate operation; first opening the breech; second, placing the gun in the loading position; third, raising the gun-loading cage; fourth, working the rammer; then by reverse motions withdrawing the rammer, lowering the cage, etc. The mechanism is so interlocked that it is impossible to work the single lever too quickly or for an accident to happen, and yet there is not a single valve in the new mechanism which is not to be found in previous well tried gun mountings. Hydraulic power is used for practically all operations. 5 illustrations. 6,500 words.—*The Engineer*, October 31.

The Saving of Heat Units in Marine Engineering.—By Lieutenant Commander Henry C. Dinger, U. S. N. A strong plea is made in this article for the adoption of combination reciprocating and turbine machinery in battleships for the purpose of bettering the economy of operation. With combination machinery it is claimed that .104 horsepower can be developed per pound of water, or that it will require 9.61 pounds of water per horsepower. The best performance that the marine turbine alone can show is about 11.5 pounds of water per shaft horsepower. It is further pointed out that combination machinery will provide for a reciprocating engine in which none of the parts is of excessive size; it makes a very simple arrangement in the engine room, reducing piping, valves and fittings; gives 50 percent of full power for backing and, owing to increase in economy, a saving of weight of 15 to 20 percent is possible. The combination is also well adapted for obtaining the benefit of a reheater and series feed heater. The actual gain in economy by the installation of such devices may be as high as 8 percent, or even more, depending on the degree of saving the process of reheating will produce. A 4 percent gain in economy, it is claimed, is almost certain. It is pointed out that if 80 percent efficiency can be secured for the reciprocating engine, which seems possible, and if some improvement can also be made in the low-pressure turbine an efficiency of 78 percent at full power for combination machinery may be expected and a water rate of 8.3 pounds per horsepower is a practical possibility. By the use of heaters

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and series feed heaters these results will be bettered still further, so that an efficiency of 80 percent for the whole range and a water consumption of about 8 pounds of water per horsepower for a large marine installation is within the limits of possibility. For certain classes of work the geared turbine is favorably mentioned. As to future possibilities, the proposition is suggested of using electric motor drive on the shafts with the current supplied partly by Diesel engines and partly by steam turbines. The exhaust from the oil engines could be utilized to assist in the generation of steam in the boilers, and the feed water for the boilers might be used as the cooling water for the oil engines. Such a combination would permit of very great economy and would at the same time enable the propellers to be operated by either the oil engine or the steam engine. Besides the main engines, the auxiliaries should be considered in any attempt to better the economy of operation of a ship. The auxiliaries on a battleship require from 15 to 25 percent of the fuel when under way and their economical operation has a most important bearing on the total fuel consumption because they are continually in operation. The principal auxiliaries are the electrical plant and the evaporator plant. These two services make up about two-thirds of the port consumption. The present average port consumption for large vessels runs at about 25 tons per day. Some of the large vessels get down to about 20 tons per day and occasionally to 18 tons. By taking advantage of improvements in auxiliary machinery it is maintained that large vessels can be brought down to a daily consumption of about 14 tons per day, provided the numerous small wastes are checked. 2 illustrations. 8,700 words. *Journal of the American Society of Naval Engineers*, August.

The Development of the Torpedo-Boat Destroyer.—By W. Lambert. After defining the scope and functions of the modern destroyer as distinguished from the former torpedo boat attention is directed to the classes of destroyers developed in succeeding years for the British Navy. Starting with the "River class," which was comprised of vessels of 550 tons displacement, and 7,500 horsepower, burning coal as fuel, the development is traced to the present-day destroyers of over 1,000 tons displacement and 32 knots speed, using oil fuel and turbine engines. Practically every form of high speed lightweight machinery has been tried in this class of vessel, and the present-day practice must be considered as the survival of the fittest. The present-day tendencies in destroyer design are undoubtedly in the direction of increased speed, armament and sea-going qualities, with a consequent increase in size. The fastest destroyer yet completed is the *Novik*, which attained on her six hours' trial a remarkable speed of 36.3 knots. Another 36-knot destroyer was built in England in 1908, named the *Swift*. Her displacement was 2,170 tons and her shaft horsepower 30,000 to 35,000, but she proved a costly experiment and has not been repeated. 12 illustrations. 2,300 words.—*The Shipbuilder*, December.

Motor Ship for the Hamburg-American Company.—A description is given of the new Junkers-Weser engined vessel *Priemus* of 2,000 horsepower, designed and built by the Weser Company for the Hamburg-American Company. She is a vessel of 6,000 tons deadweight capacity, 353 feet long overall, 50 feet extreme beam, 26 feet molded depth, 22½ feet load draft, designed for a speed of 10 knots. Theoretically the Junkers engine should be more efficient for its weight and length than any other type of Diesel engine, particularly as it is practically a double-acting motor, but its greatest drawback is probably to be found in its great height, which is caused by the tandem cylinder arrangement. Whether or not this will make any difference can hardly be told until the *Priemus* has accomplished at least one ocean-going voyage under severe conditions. There are three pairs of cylinders per engine, each pair being arranged in tandem. The bore and stroke are 16 inches and 1,000 brake horsepower is developed by each engine at 120 revolutions per minute. Its overall length is 23½ feet with 9 feet depth and height of 27½ feet. 9 illustrations. 1,700 words.—*The Marine Engineer and Naval Architect*, December.

Twenty Years' Progress in Marine Construction.—By Alexander Gracie, M. V. O., M. Inst. C. E. This article is a reprint of the James Forrest lecture delivered before the Institution of Civil Engineers on Thursday, October 23. In the tendency toward increased comfort, speed and economy in steamships increase in size is undoubtedly the most valuable resource of the naval architect, as it is directly conducive to the attainment of these three desiderata. The most notable epoch-makers of the first eighty years of steam navigation were the introduction of iron about the year 1820; of steel about 1870; of the compound engine in 1854, and of the triple expansion engine in 1881. The condition of marine construction at the beginning of the twenty-year period under review is prefaced by reference to the *Campania*, at that time the premier vessel on the Atlantic. Comparative details are then given of the various large vessels which appeared from year to year during the twenty-year period, including the *Kaiser Wilhelm der Grosse* (1897), the *Deutschland* (1900), the *Cedric* (1901), the *Kaiser Wilhelm II* (1902), and the *Amerika* and *Kaiserin Augusta Victoria* in succeeding years, until in 1905, when the turbine made its appearance on the *Victorian* and *Virginian*. The development of marine construction during recent years has brought out the *Adriatic* (1906), the *Lusitania* and *Mauretania* (1907), the *Otaki* (1908), the *Olympic* (1911) and the *Imperator* (1913). While the foregoing relates to the Atlantic service, which is of first importance in marine construction, a similar discussion is given of the development of the cross channel steamers and reference is made to the introduction of various forms of transmission gear, such as electric, hydraulic and toothed gearing. The development of the cargo or tramp steamer has undergone a no less remarkable change. Their speed has remained practically constant at 11 knots, but, while the 6,400-ton deadweight carrier of 1895 developed 1,400 indicated horsepower and consumed 20 tons of coal daily, her successor of to-day can carry 9,600 tons and steam at the same speed on an expenditure of only 32 tons daily for 2,300 indicated horsepower. Fifty percent more deadweight is carried and 64 percent more power developed, but only 33 percent has been added to the fuel consumed. The coal rate has fallen from 1.6 pounds per horsepower to 1.3 pounds, while for a 3,000-mile average the deadweight carried per ton of coal has increased from 23.5 tons to 26.4 tons. The various improvements in cargo handling gear, crew's accommodations and auxiliaries and fittings in general are enumerated. Changes in boiler design and construction have been small; and while watertube boilers have entirely superseded cylindrical boilers in warships, they have made but little progress in the favor of the average ship owner. 10,000 words.—*Engineering*, October 24.

The United States Naval Engineering Experiment Station, Annapolis, Md.—By Lieutenant Commander E. J. King, U. S. N. The author gives a comprehensive review of the experiment station as to its origin, establishment, equipment, accomplishments and aims. All tests of machinery and apparatus at the experiment station are conducted from a "service" point of view. It is regretted that the results of these tests have only a very limited circulation, and it is urged that some means should be provided for presenting the results of the tests and research work carried on at the station to the engineering world. 9 illustrations. 8,400 words.—*Journal of the American Society of Naval Engineers*, August.

NEW PIER FOR AMERICAN-HAWAIIAN STEAMSHIP COMPANY.—Work on the new American-Hawaiian Steamship Company's pier at the foot of Forty-first street, Brooklyn, N. Y., is nearing completion. The pier will be about 900 feet long, 150 feet wide and two stories high, fitted with special appliances for handling freight.

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ENGINEERING SPECIALTIES

Lunkenheimer Pop Safety Valve

The Lunkenheimer "Sentinel" pop safety valve, manufactured by the Lunkenheimer Company, Cincinnati, Ohio., is made either entirely of bronze (Fig. 1) or with iron body and bronze mounted (Fig. 3), and as the working parts are identical a description of one will suffice for both. Reference is therefore had to Fig. 1, which illustrates the bronze construction.

When a pop valve is ordered the purchaser, as a rule, stipulates the pressure at which he desires the valve to relieve, but after the valve is connected certain conditions may arise that require a resetting of the valve. With the Lunkenheimer construction it is not necessary that the entire valve be taken apart for this purpose, it being only necessary to remove the lever *U*, then the bonnet *C*, when access can be had to the regulating screw *L*. Should it be desired to have the valve

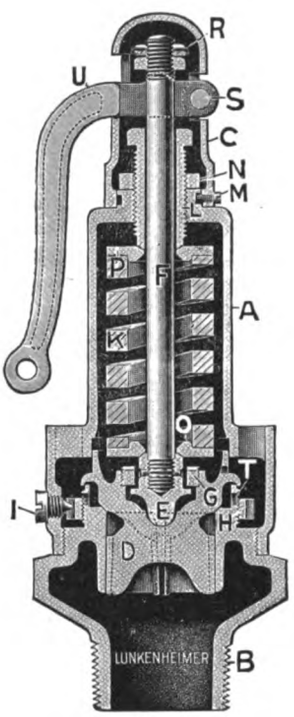

Fig. 1

Fig. 2

relieve at a higher pressure than that for which it was set, the regulating screw *L* is turned down, placing a greater load on the spring, and for a lower pressure it is turned up, which relieves the load.

It is usually found that after a valve has been reset it will either relieve too much or not enough pressure. This is rectified, in the Lunkenheimer improved construction, by a regulating ring *H*, located in the base of the valve, and which screws over an extension of the seat. The object of this ring is to cover or uncover, as the case may require, a series of holes *T* drilled around the extension of the seat, and by removing the set screw *I* and inserting a wire, the regulating ring *H* can be turned up or down as desired. By turning the ring *H* up, covering the holes, only a small quantity of steam can escape through these holes, which places a large amount of pressure on the bottom of the disk flange or lip, giving it a higher lift and holding it longer off its seat, thereby allowing considerable steam to escape and a proportionate amount of pressure. Turning the ring *H* down uncovers the holes, allowing the free escape of steam through them, but inasmuch as the pressure on the bottom of the disk flange is decreased, the disk will not rise very far off its seat, closes quicker, permits but a small amount of steam to escape, and therefore a small reduction in pressure. This improved construction, it is claimed, enables a very wide range in reduction of pressure—from as low as 1 pound to as high as 15 pounds, depending, of course, on the pressure carried in the boiler.

It will be noticed, by reference to Fig. 1, that an extension on the top of the disk *G* fits within the bottom of the bell *A*. The object of this is to thoroughly encase the spring *K*, thereby protecting it from the corrosive action of the steam.

The valve shown in Fig. 1 is of the top outlet pattern, but where it is desired to have the escaping steam exhaust at a

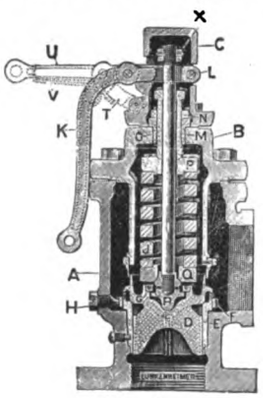

Fig. 3

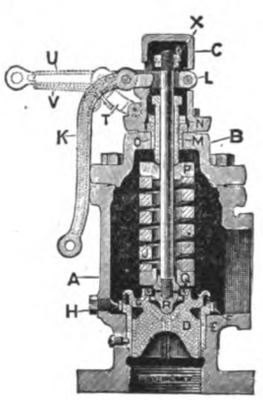

Fig. 4

distance from the valve, the angle pattern (Fig. 2) should be used, which permits of the connection of a pipe at the side.

A comparison of Figs. 3 and 4, which illustrate iron body types, will show that the working parts are practically the same, but that the spring casing has been omitted in Fig. 4, and the spring is consequently not protected from the steam. In some cases, however, it is not considered essential that the spring be encased, hence the necessity of a design like Fig. 4, which is known as the "Plain Pattern."

Thor Electric Drill

The illustration shows a marvelously compact tool, manufactured by the Independent Pneumatic Tool Company, Chicago, for drilling in steel or wood on 110 or 220 volts, direct

or single-phase alternating current. The tool is built in two sizes, with a capacity for drilling ¼-inch and 5/16-inch holes in steel or ⅜ inch and ½ inch in wood. As the tool can be attached to an ordinary incandescent lighting socket, with alternating or direct-current line, its usefulness is apparent. The spindle and armature shaft are suspended in roller and anti-friction ball bearings. The revolving parts, it is claimed, are perfectly balanced, insuring absence of vibration with great speed and power. The case is made of aluminum, and an ingenious switch at the throttle prevents short circuiting or arcing, and allows interchange of different extension lengths

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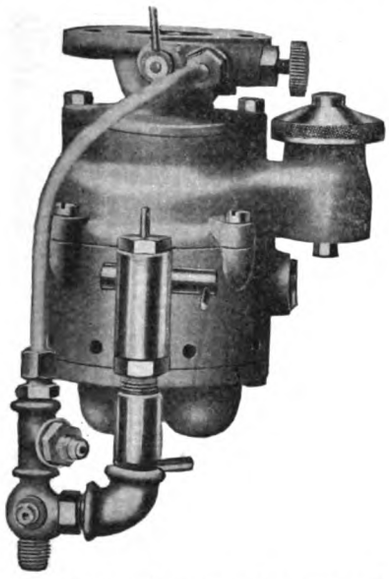
of cord. The brush holders are automatic and self-adjusted, and the armature is quickly accessible for cleaning by the removal of one nut. The motor is air-cooled by drafts of air drawn through perforated holes in the brush cover at the top of the drill, passing the motor and ejected through a number of small holes around the case, which connects with a groove on the outside of the fan. These tools weigh 6 and 7 pounds, respectively. The speed under load is 1,500 and 750 revolutions per minute, and the reaming capacity 3/16 inch and ¼ inch.

Knox Kerosene (Paraffin) Carburetor, Model E

The Camden Anchor-Rockland Machine Company, of Camden, Me., manufacturers of the Knox Marine Motor, are about to place on the market their Model E carburetor, designed especially to use kerosene (paraffin) fuel on all internal combustion motors. Its operation is briefly described as follows: The fuel is introduced into the carburetor in the usual way, but in the base of the carburetor is built a conical-shaped heating chamber. The heat is taken from the exhaust line, and the amount of heat thrown into the base of the carburetor is regulated by a damper in the exhaust line. Owing to the fact that the fuel-heating chamber is only sufficiently



large to allow the fuel to flow over the cone, and also owing to the fact that the cone is made of soft sheet copper and has a very large heating surface, there is no difficulty in gasifying the fuel as it passes by the needle valve, which the manufacturers claim is the only correct method of handling kerosene (paraffin) fuel.

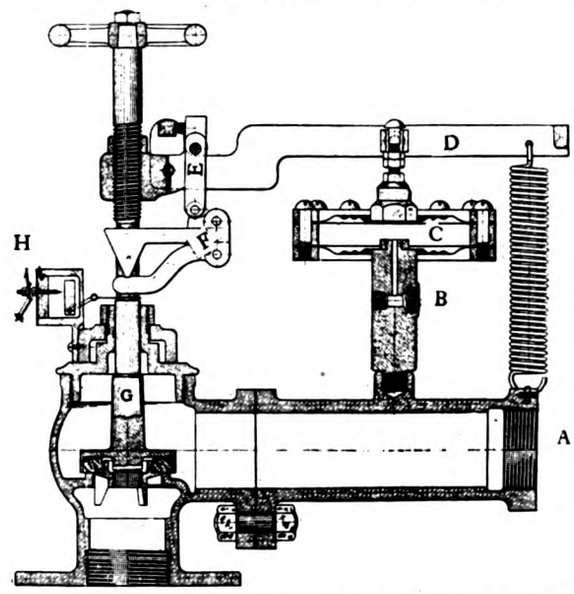
The needle valve and nozzle are of peculiar construction. The gasing fuel passes by the regulating needle into the nozzle through a series of very fine holes. The heated constant air is introduced into the nozzle through a series of small holes. This nozzle is so constructed that the fuel holes intersect the constant air holes at the outlet point, thereby atomizing the mixture as it enters the mixing chamber. The needle valve and nozzle are adjustable, and are made to lift up and down by the movement of the throttle lever. The auxiliary valve which controls the auxiliary air acts as a throttle, and no other throttle is necessary.

The special valuable features of this carburetor, which are covered by patents, are the method of heating the fuel, the method of increasing the speed of the gases and the method of thoroughly atomizing the mixture. The carburetor is so arranged that either fuel can be used—gasolene (petrol) or kerosene (paraffin)—but for convenience' sake it is constructed with a flushing valve, and the gasolene (petrol) is not passed through the carburetor. When the motor is started it receives at first gasolene (petrol) fuel by opening the flushing valve, which has a needle regulation. After running a few minutes (the time varies according to the conditions, say from 15 seconds to 3 minutes) the flushing valve is closed, and the kerosene (paraffin) fuel is picked up without any change in the regulation.

From experience the manufacturers have found that the gain in speed and power when operating on kerosene (paraffin) averages about 7 percent over gasolene (petrol), the fuel consumption remaining practically the same. Under ordinary conditions the marine motor can be started cold on kerosene (paraffin) by simply giving it a good priming charge of gasolene (petrol).

"Nyasco" Fire Protection System

The "Nyasco" system of fire detection and extinguishment in cargo holds, tank ships, tank barges, etc., consists of an automatic releasing valve, together with an open system of piping attached to the valve at *A* for distributing the extinguishing agent, and a smaller closed system of piping attached to the valve at *B*, containing air under a light pressure and provided with fusible plugs at proper intervals in the



space to be protected. The fusing of one or more of these plugs releases the air in the diaphragm *C*, and the controlling bar *D* falls, disengaging the trip lever *E* from the two-piece strut *F*, thereby permitting spindle *G* to rise, thus releasing the extinguishing agent into the distributing system *A*, at the same time sounding an alarm through circuit closer *H*.

The value of any form of alarm is enhanced when the delivery of the extinguishing agent is coincident with such alarm. This, it is claimed, is accomplished by the "Nyasco" system. The fact that quite often the fire is discovered or detected so long after its inception that it has attained proportions that make it practically invulnerable to attack, proves the necessity of automatic action of the extinguishing agent. Whether such automatic system be the water sprinkle type or for the distribution of steam or gases, the "Nyasco" system can be adapted. The valve is simple in construction, positive in action, and by reason of these features it is claimed the system is rendered thoroughly dependable. The air pressure maintained need not exceed 20 pounds per square inch under any conditions, as the pressure on the seat of spindle *G* bears no relation to the air pressure in diaphragm *C*. No auxiliary apparatus is required other than a small air pump

This apparatus is manufactured by the New York Automatic Sprinkler Company, New York City.

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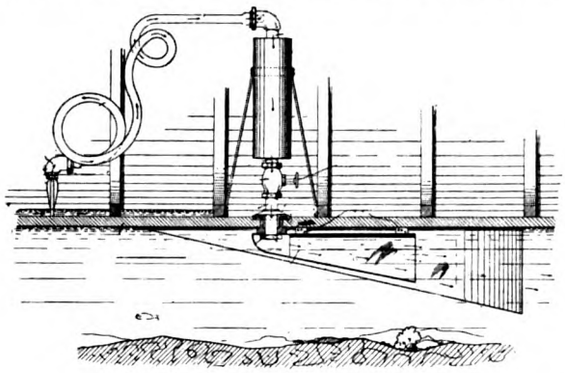
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,072,398. BILGE-WATER DISCHARGER. EUGENE LANGLEY, OF SAN ANTONIO, TEX.

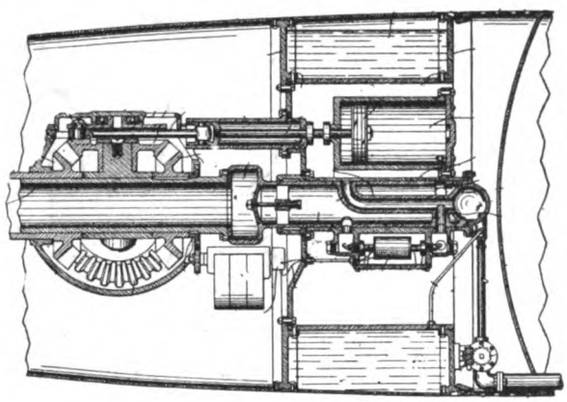
Claim 1.—In a device of the kind described, a check valve consisting of a cylindrical casing having a bushing at each end, rings within said casing bearing against said bushing, a nozzle carried by the upper ring,



pairs of rods connecting said rings, a stop plate fixedly mounted on two of said rods, and a ball valve normally resting on the stop plate. Five claims.

1,077,311. SUBMARINE TORPEDO. HAROLD W. SHONNARD, OF EAST ORANGE, N. J.

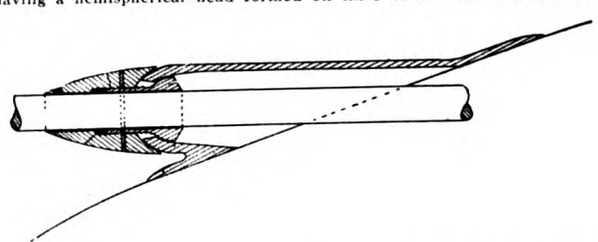
Claim 1.—In a self-propelled torpedo, a water-tight bulkhead, a propeller shaft having its forward end near side bulkhead, a compartment accessible to the seat directly forward of said bulkhead, a heat



engine in said compartment comprising cylinders and pistons grouped around the axis of and suitably connected with said shaft, a tight valve casing piercing said bulkhead in the line of said shaft, and a rotary valve for said cylinders within said valve casing, attached to said shaft. Fifteen claims.

1,075,080. STUFFING-BOX AND BEARING FOR SHAFTS OF MARINE PROPELLERS. HENRY DOUGLAS BACON, OF BATH, MAINE.

Claim 2.—The combination with a chambered housing adapted to be attached to a boat hull and having a conical outer end, a sleeve bearing having a hemispherical head formed on lines concentric with the inner



and outer sides of the end of the housing, a locking nut screwed on the sleeve and having its inner face formed concentrically with the adjacent end of the sleeve bearing, and a fair-water nut also screwed on the sleeve bearing and tapered toward its outer end on lines coinciding with the outer side of the locking nut. Two claims.

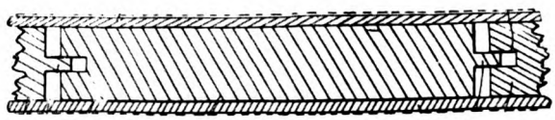
1,078,270. SCREW-PROPELLER. ANTOINE PADOUE FILIPPI, OF PARIS, FRANCE.

Claim.—A screw propeller comprising a plurality of blades, in each of which the pitch increases from the hub to the end, and from the leading edge to the trailing edge, the front face of each blade being provided with an inclined surface adjacent its trailing edge and adjacent the hub of the propeller, the rear face of each blade being provided with an inclined surface adjacent the hub of the propeller, the planes of said inclined surfaces intersecting one another and passing through the shaft of the propeller, such diverting surfaces forming suitable angles with the blades. One claim.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

6106/1913. BULKHEAD FOR SHIPS. ALEXANDER STEPHEN & SONS, LTD., OF LINTHOUSE, GOVAN AND R. M'ILMOIL.

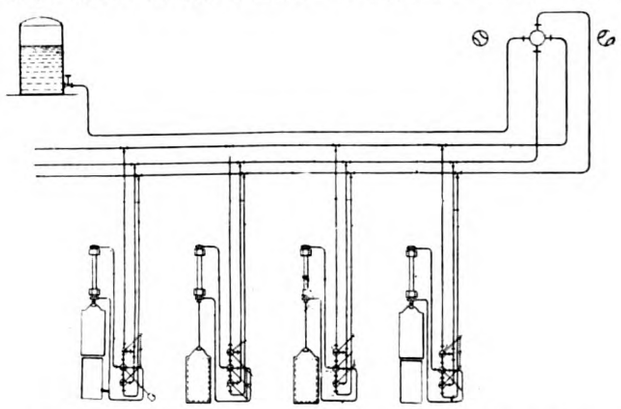
Claim.—To improve the construction of ships' bulkheads they are made fireproof and are so constructed that they do not warp or open out though subjected to extremes of temperature. The bulkhead is



built up of plain wooden boarding lined on each side with sheets of fireproof composition of asbestos and cement secured by nailing. The boards are preferably checked or dovetailed and are arranged with a slight space between to allow for expansion of the wood.

10562/1913. DEVICES FOR USE IN CONTROLLING THE BULKHEAD DOORS ON SHIPS, ATLAS-WERKE AKT. GES. OF "AM TREIHAFEN," BREMEN, GERMANY.

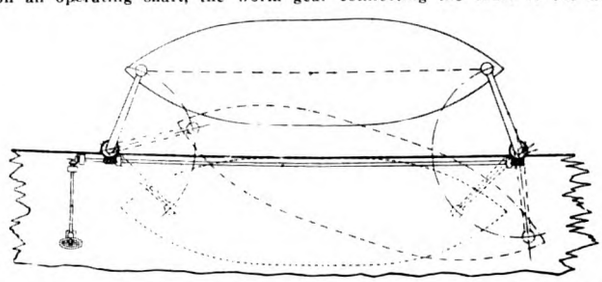
Claim.—A device for use in controlling the bulkhead doors in ships comprises a pressure conduit and a common discharge conduit, two further common conduits being provided and adapted to serve either as pressure or discharge conduits. The supply and discharge conduits



individual to each door operating cylinder are connected to a four-way cock which is interposed between the two three-way cocks individual to that door. The plug levers of the three-way cocks are coupled together to move in unison and the lever of the corresponding four-way cock is movable independently so that when all the doors have been closed from the central controlling point any individual door may be opened locally and caused to be automatically closed upon the lever of the four-way cock being released.

21888/1912. APPARATUS FOR HANDLING AND LAUNCHING SHIPS' BOATS. H. MOWATT, OF 28 PALM GROVE, BIRKENHEAD, CHESTER, AND C. H. BUTTERWORTH.

Claim.—According to this invention each davit of a boat handling and launching gear is provided with a worm-wheel and worms mounted on an operating shaft, the worm gear connecting the shaft to the aft



davit having a higher velocity ratio than the other, and having a limited free rotational movement relatively to the davit. The other worm wheel is keyed to the fore davit whereby the rotation of the operating shaft for launching the boat, although it rotates both in the first instance, only swivels the fore davit—through a considerable arc; the aft davit meanwhile can swivel in-board. When the limiting stops of the worm wheel on the aft davit engage, the latter is swiveled out-board, and the two velocity ratios are such that both davits reach the full out-board position together.

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